Appendix E

Applicant's Environmental Report

Operating License Renewal Stage

Clinton Power Station

November 2023

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Abbreviations, Acronyms, and Symbols

20 ILCS 662	Illinois Local Planning Technical Assistance Act
§	Section
°C	degrees Celsius
°F	degrees Fahrenheit
AADT	average annual daily traffic
AC&H	Archaeological, Cultural, and Historical resources
AEA	Atomic Energy Act
AIF	actual intake flow
ALARA	as low as reasonably achievable
APE	area of potential effect
AQCR	air quality control region
AREOR	annual radiological environmental operating report
ARERR	annual radiological effluent release reports
AST	aboveground storage tank
AUID	Assessment Unit ID
BGEPA	Bald and Golden Eagle Protection Act
bgs	below ground surface
BIC	balanced indigenous community
BMP	best management practice
BTA	best technology available
BWR	boiling water reactor
Btu/KWh	British Thermal Unit to kilowatt-hour
CAA	Clean Air Act
CDC	Center for Disease Control
CEG	Constellation Energy Generation, LLC
CEJA	Climate and Equitable Jobs Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm/s	centimeters per second
CMP	Coastal Management Program
CPE	catch per effort

CPS	Clinton Power Station
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWA	Clean Water Act (Federal Water Pollution Control Act)
CWIS	cooling water intake structure
dBA	A-weighted decibels
DIF	design intake flow
DOE	U.S. Department of Energy
DSM	demand-side management
EAB	exclusion area boundary
EcoCAT	Ecological Compliance Assessment Tool
EFH	essential fish habitat
EGC	Exelon Generation Company
EMP	Environmental Monitoring Program
EPA	U.S. Environmental Protection Agency
ER	environmental report
ERAT	Emergency Reserve Auxiliary Transformer
ESA	Endangered Species Act
ESP	Early Site Permit
FAA	Federal Aviation Administration
FD	fire department
FE	federally endangered
FEMA	Federal Emergency Management Agency
FESOP	Federally Enforceable State Operating Permit
FPPA	Farmland Protection Policy
FT	federally threatened
ft/day	feet per day
ft/ft	feet per foot
FY	fiscal year
GCB	Gas Circuit Breaker
GEIS	NUREG-1437, *Generic Environmental Impact Statement for License*

	Renewal of Nuclear Plants, Revision 1
GHG	greenhouse gas
gpd	gallons per day
GPI	Groundwater Protection Initiative
gpm	gallons per minute
HAP	hazardous air pollutant
HAPC	habitat areas of particular concern
HARGIS	Historic and Architectural Geographic Information System
HSRPA	Human Skeletal Remains Preservation Act
I-57	Interstate 57
ICRMRA	Illinois Cultural Resource Management Report Archive
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IHPD	Illinois Historic Preservation Division
IIAS	Illinois Inventory of Archaeological Sites
IL 10	Illinois Route 10
IL 54	Illinois Route 54
IPA	integrated plant assessment
IPC	Illinois Power Company
ISGS	Illinois State Geological Survey
ISFSI	independent spent fuel storage installation
kg	kilogram
KPIA	Peoria, Illinois, weather station
KSPI	Springfield, Illinois, weather station
kV	kilovolt
kW	kilowatt
LEPC	Local Emergency Planning Committee
LLD	lower limit of detection
LLRW	low-level radioactive waste
LOCA	loss-of-coolant accident

LOS	level of service
LR	license renewal
LRA	license renewal application
m^3	cubic meters
mA	milliamperes
MBTA	Migratory Bird Treaty Act
MDCT	mechanical draft cooling tower
mg/L	milligram per liter
MGD	million gallons per day
MGM	millions of gallons per month
MGY	millions of gallons per year
MISO	Midcontinent Independent System Operator
MM	modified Mercalli
mph	miles per hour
MPT	Main Power Transformer
mrem	millirem
MSL	mean sea level
MW	megawatts
MWe	megawatts electric
MWh	megawatt hours
MWPH	makeup water pump house
MWt	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NCEI	National Centers for Environmental Information
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NESC	National Electrical Safety Code
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NGCC	natural gas combined cycle
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide

NOAA	National Oceanic and Atmospheric Administration
NOV	notice of violation
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NWI	National Wetlands Inventory
NWS	National Weather Service
ODCM	Offsite Dose Calculation Manual
OL	operating license
OSHA	Occupational Safety and Health Administration
PA	protected area
PAA	Power Agency Act
PAM	Primary Amebic Encephalitis
Pb	lead
pc/h/ln	passenger cars per hour per lane
pCi/L	picoCuries per liter
PEL	permissible exposure limit
PEO	period of extended operation
pH	potential hydrogen
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
PM	particulate matter
PM_{10}	particulate matter less than 10 micrometers in diameter
PMF	probable maximum flood
ppm	parts per million
PSWS	plant service water system
PV	photovoltaic
RAT	Reserve Auxiliary Transformer
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
REMP	radiological environmental monitoring program

RGPP	radiological groundwater protection program
ROW	right-of-way
SCAB	Supplemental Cooling and Auxiliary Boiler
SDWA	Safe Drinking Water Act
SE	state endangered
SHPO	state historic preservation officer
SMITTR	surveillance, monitoring, inspections, testing, trending, and recordkeeping
SNF	spent nuclear fuel
SO_2	sulfur dioxide
SPCC	spill prevention, control, and countermeasure
SSA	sole source aquifer
SSC	systems, structures, and components
ST	state threatened
STP	sanitary wastewater treatment lagoon system
SU	standard units
SWPPP	stormwater pollution prevention plan
SX	shutdown service water system
TDEC	Tennessee Department of Environment and Conservation
TEDE	total effective dose equivalent
TRB	U.S. Transportation Research Board
TSS	total suspended solids
UDEQ	Utah Department of Environmental Quality
UHS	ultimate heat sink
USAR	updated safety analysis report
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOM	volatile organic matter

WinMACCS	Windows MELCOR Accident Consequences Code System
YOY	young-of-the-year

1.0 INTRODUCTION

1.1 Purpose of and Need for Action

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act (AEA) of 1954, as amended, and the NRC implementing regulations. Constellation Energy Generation, LLC (CEG) owns and operates Clinton Power Station (CPS) Unit 1 pursuant to the NRC operating license (OL) NPF-62. The current Unit 1 OL will expire at midnight on April 17, 2027. (NRC 1987) CPS is located in DeWitt County, approximately 7 miles east of the city of Clinton in east-central Illinois (Table 3.11-1).

CEG has prepared this environmental report (ER) in conjunction with its application to the NRC for a renewal of the CPS OL, as provided by the following NRC regulations:

- Title 10, Energy, Code of Federal Regulations (CFR), Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Section 54.23, Contents of Application – Environmental Information [10 CFR 54.23], and
- Title 10, Energy, CFR, Part 51, Environmental Protection Requirements for Domestic Licensing and Related Regulatory Functions, Section 51.53, Postconstruction Environmental Reports, Subsection 51.53(c), Operating License Renewal Stage [10 CFR 51.53(c)]

The NRC has defined the purpose and need for the proposed action, renewal of the OL for nuclear power plants such as CPS, as follows (NRC 2013a):

> *The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning-decisions-makers, such as State, utility, and where authorized, Federal agencies (other than the NRC). Unless there are findings in the safety review required by the Atomic Energy Act or the NEPA [National Environmental Policy Act] environmental review that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of whether a particular nuclear power plant should continue to operate.*

The renewed OL would allow for an additional 20 years of operation for CPS Unit 1 beyond its current licensed operating period. The renewed license for Unit 1 would expire at midnight on April 17, 2047. CEG has prepared Table 1.1-1 to verify compliance with license renewal (LR) environmental regulatory requirements. Table 1.1-1 indicates the sections in the CPS LR ER that respond to each requirement of 10 CFR 51.45 and 10 CFR 51.53(c).

Table 1.1-1 Environmental Report Compliance with License Renewal Environmental Regulatory Requirements (Sheet 1 of 3)

Description	Requirement	ER Section(s)
Environmental Report-General Requirements [10 CFR 51.45]		
Description of the proposed action	10 CFR 51.45(b)	2.1
Statement of the purposes of the proposed action	10 CFR 51.45(b)	1.1
Description of the environment affected	10 CFR 51.45(b)	3.0
Impact of the proposed action on the environment	10 CFR 51.45(b)(1)	4.0
Adverse environmental effects which cannot be avoided should the proposal be implemented	10 CFR 51.45(b)(2)	6.3
Alternatives to the proposed action	10 CFR 51.45(b)(3)	2.6, 7.0, 8.0
Relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity	10 CFR 51.45(b)(4)	6.5
Irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented	10 CFR 51.45(b)(5)	6.4
Analysis that considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects	10 CFR 51.45(c)	2.6, 4.0, 7.0, 8.0
Federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and description of the status of compliance with these requirements	10 CFR 51.45(d)	9.1
Status of compliance with applicable environmental quality standards and requirements which have been imposed by federal, state, regional, and local agencies having responsibility for environmental protection, including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements	10 CFR 51.45(d)	9.5
Alternatives in the report to include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements	10 CFR 51.45(d)	9.7
Information submitted pursuant to 10 CFR 51.45(b) through (d) and not confined to information supporting the proposed action but also including adverse information	10 CFR 51.45(e)	4.0, 6.3, 7.0, 9.3, 9.5

Table 1.1-1 Environmental Report Compliance with License Renewal Environmental Regulatory Requirements (Sheet 2 of 3)

Description	Requirement	ER Section(s)
Operating License Renewal Stage [10 CFR 51.53(c)]		
Description of the proposed action including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21. The report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities	10 CFR 51.53(c)(2)	2.1, 2.3, 2.4, 3.0, 4.0
Analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for applicable Category 2 issues.	10 CFR 51.53(c)(3)(ii)	4.0
Surface Water Resources		
Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.5.1
Groundwater Resources		
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.5.2
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm])	10 CFR 51.53(c)(3)(ii)(C)	4.5.3
Groundwater quality degradation (plants with cooling ponds at inland sites)	10 CFR 51.53(c)(3)(ii)(D)	4.5.4
Radionuclides released to groundwater	10 CFR 51.53(c)(3)(ii)(P)	4.5.5
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling ponds)	10 CFR 51.53(c)(3)(ii)(B)	4.6.1
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	10 CFR 51.53(c)(3)(ii)(B)	4.6.2
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.6.3

Table 1.1-1 Environmental Report Compliance with License Renewal Environmental Regulatory Requirements (Sheet 3 of 3)

Description	Requirement	ER Section(s)
Terrestrial Resources		
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.6.4
Effects on terrestrial resources (non-cooling system impacts)	10 CFR 51.53(c)(3)(ii)(E)	4.6.5
Special Status Species and Habitats		
Threatened, endangered, and protected species, and essential fish habitat	10 CFR 51.53(c)(3)(ii)(E)	4.6.6
Historic and Cultural Resources		
Historic and cultural resources	10 CFR 51.53(c)(3)(ii)(K)	3.8, 4.7
Human Health		
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	10 CFR 51.53(c)(3)(ii)(G)	4.9.1
Electric shock hazards	10 CFR 51.53(c)(3)(ii)(H)	4.9.2
Environmental Justice		
Minority and low-income populations	10 CFR 51.53(c)(3)(ii)(N)	3.11.2, 4.10.1
Cumulative Impacts		
Cumulative impacts	10 CFR 51.53(c)(3)(ii)(O)	4.12
Postulated Accidents		
Severe accident mitigation alternatives (SAMA) analysis	10 CFR 51.53(c)(3)(ii)(L)	4.15
All Plants		
Consideration of alternatives for reducing adverse impacts for all Category 2 license renewal issues	10 CFR 51.53(c)(3)(iii)	4.0, 6.2
New and significant information regarding the environmental impacts of license renewal of which the applicant is aware	10 CFR 51.53(c)(3)(iv)	4.0, 5.0

1.2 Environmental Report Scope and Methodology

NRC regulations for domestic licensing of nuclear power plants require reviews of environmental impacts from renewing an OL. NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document entitled, "Applicant's Environmental Report – Operating License Renewal Stage." In determining what information to include in the CPS LR applicant's ER, CEG has relied on NRC regulations and the following supporting documents that provide additional insight into the regulatory requirements:

- NUREG 1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), Revision 1 (NRC 2013a), and referenced information specific to transportation (NRC 1999)
- NRC supplemental information in the *Federal Register* (78 FR 37282)
- *Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses* (NRC 1996a) *Regulatory Guide 4.2, Supplement 1, Revision 1, Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications* (NRC 2013b)

1.3 CPS Licensee and Ownership

CPS's owner, CEG, was formed in 2022 by the successful separation of Constellation and Exelon Generation from their former parent company, Exelon Corporation. CEG is the nation's largest producer of carbon-free energy and the leading competitive retail supplier of power and energy products and services for homes and businesses across the United States. Headquartered in Baltimore, MD, CEG's generation fleet powers more than 20 million homes and is helping to accelerate the nation's transition to clean energy. (CEG 2022a; NRC 1987)

2.0 PROPOSED ACTION AND DESCRIPTION OF ALTERNATIVES

2.1 The Proposed Action

In accordance with 10 CFR 51.53(c)(2), a LR applicant's ER must contain a description of the proposed action. The proposed action is to renew, for an additional 20-year period, the OL for CPS Unit 1, which would preserve the option for CEG to continue operating CPS and provide reliable baseload power for the proposed LR term. For CPS Unit 1, the proposed action would extend the OL from April 17, 2027, to April 17, 2047.

CEG does not anticipate any LR-related refurbishment activities as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. The relationship of refurbishment to LR is described in Section 2.3.

Changes to surveillance, monitoring, inspections, testing, trending, and recordkeeping (SMITTR) would be implemented as a result of the 10 CFR Part 54 aging management review for CPS. There are no plans associated with LR to modify the facility or its administrative controls other than the procedures necessary to implement the aging management programs described in the integrated plant assessment (IPA).

2.2 General Plant Information

A LR applicant's ER must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures. The report must describe in detail the affected environment around the plant and the modifications directly affecting the environment or any plant effluents [10 CFR 51.53(c)(2)].

The principal structures at CPS are the following: containment, auxiliary building, fuel building, turbine building, radwaste building, control building, diesel generator and HVAC building, circulating water screen house, service building, makeup water pump house, switchyard, mechanical draft cooling towers (MDCTs), outdoor storage tanks, permanent warehouse, and the gatehouse. The layout of these structures are depicted in Figure 3.1-1. (EGC 2020a)

As discussed in Section 3.1.2, the exclusion area falls entirely within the station property and is a 975-meter radius circle centered on the station standby gas treatment system vent (EGC 2020a). CEG owns all the property in the exclusion area with the exception of a right-of-way (ROW) for the public road which traverses the exclusion area. This road provides access to privately owned property which lies outside the exclusion area within the peninsula area between the Salt Creek finger and the North Fork of the Salt Creek finger of Clinton Lake. The property ownership and the mineral rights provide CEG the authority to determine all activities, including exclusion and removal of personnel and property from the exclusion area. (EGC 2020a)

2.2.1 Reactor and Containment Systems

As shown in Figure 3.1-1, CPS is a single unit (Unit 1) station. Unit 1 has a boiling water reactor (BWR) nuclear steam supply system as designed and supplied by the General Electric Company and designated as a BWR/6 unit. The containment system designed by Sargent & Lundy employs the drywell/pressure suppression features of the BWR-Mark III containment concept. The containment is a right cylindrical, reinforced concrete, steel-lined pressure vessel with a hemispherical dome. (EGC 2020a)

The Unit 1 OL was issued in September 1986 and commercial operation commenced in April 1987. Unit 1 was originally licensed to operate at a maximum power level of 2,894 megawatts thermal (MWt). In 2002, CPS undertook a program to uprate the maximum reactor power level by 20 percent to 3,473 MWt. An increase in the electrical output of the CPS BWR was accomplished by supplying a higher steam flow rate to the turbine generator. At the uprated reactor power level, the general electrical output increased approximately 186 megawatts electric (MWe). (CEG 2002) The unit is designed to operate at a gross electrical power output of approximately 1,138.5 MWe (EGC 2020a).

The containment houses the major portion of the nuclear steam supply system, the drywell, the suppression pool, and the containment pool. The drywell encloses the reactor pressure vessel, the reactor coolant recirculation loops and pumps, and other branch connections of the primary system. The drywell is a cylindrical reinforced concrete structure with a removeable steel head. The suppression pool serves as a heat sink during normal operational transients and accident conditions. It contains a large amount of water used to rapidly condense steam from a reactor vessel blowdown or from a break in a major pipe. The containment upper pool is used for shielding, refueling operations, and as makeup to the suppression pool. The containment vessel surrounds the drywell and the suppression pool. The containment building is formed by an upright cylinder, founded on a soil-supported flat concrete slab, and covered with a hemispherical dome. This reinforced-concrete pressure vessel is lined with steel plate which serves as a leak-tight membrane. (EGC 2020a)

The nuclear system includes a direct cycle, forced circulation, BWR that produces steam for direct use in the steam turbine. The major reactor internal components are the core (fuel, channels, control blades, and incore instrumentation), the core support structure (including the shroud, top guide, and core plate), the shroud head and steam separator assembly, the steam dryer assembly, the feedwater spargers, the core spray spargers, and the jet pumps (EGC 2020a).

The BWR core is comprised of essentially two components – fuel assemblies and control rods (EGC 2020a). The reactor contains 624 fuel assemblies. Each assembly consists of a matrix of zircaloy or ZIRLO clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide as fuel material, and water rod(s). The reactor core contains 145 cruciform shaped control rod assemblies. (NRC 1987) Power distribution in the core is controlled during operation of the reactor by manipulating selected patterns of control rods. The control rod consists of an array of stainless-steel wings filled with boron-carbide powder. The control rods are 9.868 inches in total span and are separated uniformly throughout the core on a 12-inch pitch maximum. Each control rod is surrounded by four fuel assemblies. (EGC 2020a)

Peak pellet exposure is limited per the core design process to 70 gigawatt-days per metric ton of uranium. The maximum rod burnup limit for loading fuel in casks is 61.75 gigawatt-days per metric ton of uranium. CPS is currently licensed for maximum enrichment of 5 percent U-235, but only enriches fuel up to 4.9 percent. CEG does not anticipate the limit for maximum rod burnup or enrichment to change during the license renewal period.

2.2.2 Maintenance, Inspection, and Refueling Activities

Various programs and activities at the station maintain, inspect, test, and monitor the performance of station equipment and are detailed throughout the updated safety analysis report (USAR). Maintenance of station safety related systems, structures, and components (SSCs) is performed in accordance with written procedures, documented instructions, or drawings appropriate to the circumstances (for example, skills normally possessed by qualified maintenance personnel may not require detailed step-by-step delineation in a written procedure) which conform to applicable codes, standards, specifications, criteria, etc. When appropriate sections of related vendor manuals, instructions, or approved drawings with acceptable tolerances do not provide adequate guidance to assure the required quality of work, an approved written maintenance procedure is provided.

Routine maintenance performed on station systems and components is necessary for safe and reliable operation of a nuclear power plant. Some of the maintenance activities conducted at CPS include inspection, testing, and surveillance to maintain the current licensing basis of the station and to ensure compliance with environmental and public safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. Outages are scheduled for refueling and for certain types of repairs or maintenance, such as replacement of a major component.

Scheduled refueling outages commonly last approximately 19 days. Approximately 1,097 additional temporary workers are brought in for each outage cycle. For CPS, one refueling cycle is scheduled every 24 months.

2.2.3 Cooling and Auxiliary Water Systems

2.2.3.1 Circulating Water System

CPS uses Clinton Lake, a man-made, run-of-the-river impoundment of water as its source of cooling water. Clinton Lake was constructed as a cooling lake as part of the station's cooling system. (IEPA 2021a)

Clinton Lake is a 4,895-acre freshwater lake created by the construction of an earthen dam 1,200 feet downstream of the confluence of Salt Creek and the North Fork of Salt Creek. Clinton

Lake is a V-shaped reservoir, with a total of 130 miles of shoreline. The circulating water system at CPS consists of a cooling lake, a cooling water intake structure (CWIS), a condenser, and a discharge flume. Cooling water travels through the traveling water screens to a common plenum with the circulating water pumps. Cooling water passes through the station, cooling the condenser for the BWR. The discharge flume is an unlined, earthen, manmade canal that routes the cooling water along a 3.4-mile route, after which it discharges into the Salt Creek arm of Clinton Lake. (IEPA 2021a)

MDCTs were installed along the discharge flume in 2018 and 2019 to provide additional cooling seasonally for the water discharge to ensure compliance with National Pollutant Discharge Elimination System (NPDES) permit temperature limits. The cooling towers are triggered by a flume temperature of 109 degrees Fahrenheit (°F). CPS tracks the number of days that the thermal discharge daily average is greater than 99°F. CPS may turn on the cooling towers to reduce the discharge temperature below 99°F in compliance with the 90-calendar-day limit. The MDCTs consist of two banks with 46 cells total and typically operate from May to September.

As shown in Figure 2.2-1, the circulating water system delivers water from the cooling lake to the main condenser in sufficient quantities to condense the steam exhausted from the main and auxiliary turbines. The cooling lake is designed to dissipate the rejected heat before the water returns to the system intake in the screen house. The cooling lake is designed to maintain the temperature of the water entering the circulating water system within the range of 32°F to 95°F. The circulating water system includes a warm water circulation subsystem to maintain a 40°F minimum temperature for the water delivered to the condenser. (EGC 2020a)

The circulating water system consists of the following components: screen house, intake screens, circulating water pumps, pump building, tube side of the main condenser, condenser water box air evacuation subsystem, fill water subsystem, water box drain subsystem and all required piping and valving (EGC 2020a). The screen house serves as a CWIS to provide a continuous supply of water from Clinton Lake to the Unit 1 reactor and non-contact cooling system. The CWIS was designed with 14 bays for two potential operating units, however, seven bays are unused for Unit 2 (which was never constructed) and are not connected to other bays. Of the remaining seven bays that supply water to Unit 1, six provide cooling water to the circulating water pumps and one provides water to the service water pumps. There are three circulating water pumps, two service water pumps, and one standby service water pump in the screen house. (IEPA 2021a)

The cooling water is circulated by three motor-driven pumps (EGC 2020a). The design flow per pump is 220,000 gpm or 316.8 million gallons per day (MGD) (IEPA 2021a). As shown on Figure 2.2-1, the average intake cooling water flow is approximately 611,111 gpm (880 MGD). The circulating water pumps are housed in a building that provides the pumps and motors with shelter from snow, ice, and freeze protection for the motor bearing cooling lines. The three pumps are arranged in parallel and discharge into a common header. The discharge of each pump is fitted with a butterfly valve. This arrangement permits isolation of any one pump while the other two remain in operation. (EGC 2020a)

A designed chemical treatment capability is provided to prevent an accumulation of biological growth and scale buildup within the wetted surfaces of the circulating water system. During periodic, intermittent treatments, sodium hypochlorite is injected in an automatic and controlled manner to minimize biological growth. The injections occur via the circulating water system pump suctions located in the circulating water screen house. In addition, the design capability of the chemical treatment system provides an automatic, controlled and continuous injection of a scale inhibitor into the discharge of the circulating water system pumps. The scale inhibitor is used to prevent formation of insulating scale deposits on the main condenser heat transfer surfaces. The chemical treatment capability and the total residual chemical concentrations in the discharge to the cooling lake (Ultimate Heat Sink) are subject to the environmental discharge limitations of the NPDES Permit. (EGC 2020a)

2.2.3.2 Component Cooling Water System

The component cooling water system is a closed-loop system providing cooling to auxiliary equipment over the full range of normal reactor operation, normal shutdown, and testing conditions. The closed loop provides a barrier between nonessential contaminated systems and the plant service water discharged to the environment. Heat is removed from the closed loop by the plant service water system (PSWS). Since the component cooling water system may not be available under emergency conditions, it is designed with the capability to transfer fuel pool cooling heat exchangers to the shutdown service water system during loss of offsite AC power and/or loss-of-coolant accident (LOCA) conditions. The portion of the component cooling water system penetrating the containment is designed to permit containment isolation under all station conditions. A radiation monitor is provided in the component cooling water system to indicate leakage into this system from the potentially radioactive systems. (EGC 2020a)

2.2.3.3 Turbine Building Closed Cooling Water System

The turbine building closed cooling water system is designed to cool the station auxiliary equipment associated with the power conversion systems over the full range of normal station operation and normal shutdown. (EGC 2020a)

The turbine building closed cooling water system is a closed loop system providing cooling water to auxiliary equipment in the turbine building. The system consists of pumps, heat exchangers, a water storage tank, piping, valves, and instrumentation. Each pump is capable of handling full flow based on maximum normal cooling requirements. The turbine closed cooling water system heat exchangers reject heat from the system to the station's service water system. (EGC 2020a)

2.2.3.4 Fuel Pool Cooling and Cleanup System

The fuel pool cooling and cleanup system maintains the water temperature, purity, and radiation level in the spent fuel and upper containment pools within acceptable limits. This system has two 100 percent capacity processing trains with each consisting of a transfer pump, filter demineralizer unit, and heat exchanger. Each heat exchanger is designed to provide the required cooling capacity to accommodate expected long term spent fuel storage. Both processing trains may be operated in parallel for cooling larger-than-expected heat loads. The residual heat removal system is connected to the fuel pool cooling and cleanup system to provide supplemental cooling during shutdown, if necessary. A filter-demineralizer unit is employed to maintain water purity and control radioactive exposure. (EGC 2020a)

2.2.3.5 Service Water System

The service water system consists of two separate systems, the PSWS, and the shutdown service water system (EGC 2020a). The plant service water pumps, two operating and one in standby, have a design flow per pump of 22,000 gpm (31.7 MGD) (IEPA 2021a). There are three shutdown service water pumps, two with a capacity of 16,500 gpm (23.76 MGD) and one with a capacity of 1,100 gpm (1.6 MGD) (EGC 2020a). As shown in Figure 2.2-1, the PSWS averages an intake of 59,028 gpm (85.0 MGD).

The PSWS is designed to cool station auxiliaries which are not required for safe reactor shutdown and can be efficiently cooled by lake water. The system draws water from the cooling lake, pumps the coolant through the heat exchangers, and discharges it into the circulating water discharge, which is directed back to the station cooling lake. A radiation monitor is provided to monitor the discharge. (EGC 2020a)

The PSWS is cross connected to the fire protection system. The PSWS will also supply water to the makeup demineralizer system and to the circulating water system. The system pumps furnish water to the circulating water traveling screen wash system. The screen wash system keeps the circulating water traveling screens free of debris. (EGC 2020a) The traveling water screens have trays that are 11'9" wide with No. 12 gauge galvanized 3/8-inch square mesh openings. The screens rotate at low and high speeds of 2.8 and 11.2 feet per minute, respectively. Fish and debris that are collected on the screens are washed into a trough located parallel to the traveling water screens. Fish and debris travel along a sluiceway that empties into a collection basket for disposal. (IEPA 2021a)

2.2.3.6 Ultimate Heat Sink

The ultimate heat sink (UHS) for emergency core cooling is a submerged pond within Clinton Lake and an intake flume of 590 acre-feet capacity that underlies Clinton Lake. The UHS provides sufficient water volume and cooling capability for the station for at least 30 days with no water makeup. It is capable of withstanding the most severe natural phenomenon and postulated station-related incidents. (EGC 2020a)

The CPS cooling lake provides cooling water for the station's circulating water and service water systems. Circulating water and service water are taken at the circulating water screen house, passed through the station, and recirculated back to the lake. During normal station operation when water is being recirculated back to the lake, the lake's approximately 3,650 acres of effective surface area dissipates heat resulting from station operation. Therefore, the station operation is reliant on the lake. (EGC 2020a)

The UHS has sufficient volume to accommodate the station emergency requirements in the event of a loss of the Clinton Lake dam while maintaining the inlet temperature to the station below the shutdown service water design temperature limit. Water is taken from the UHS by the shutdown service water pumps. The water is pumped through the station auxiliaries and returned through piping to the UHS. (EGC 2020a)

The UHS can provide a minimum of 900,000 gallons of water for fire protection requirements if required with no reduction in cooling capability. Makeup for this fire protection water is from the cooling lake under normal operating conditions. (EGC 2020a)

2.2.3.7 Condensate Storage and Transfer System

The condensate storage and transfer system stores condensate and distributes it to the main condenser, reactor core isolation cooling system, and high-pressure core spray system. The system is designed to maintain the water level of condensate in the condenser hotwell and provide condensate quality water to other station systems, as required. The condensate storage facility supplies water to the fuel pool cooling and cleanup surge tanks, to provide makeup to the fuel pool for refueling, fuel shipping, and storage cask loading operations. The system consists of a condensate storage tank (with a capacity of approximately 400,000 gallons), a reactor core isolation cooling system storage tank (with a capacity of 125,000 gallons), three condensate transfer pumps, piping, valves, and instrumentation. (EGC 2020a)

2.2.3.8 Raw Water Treatment Plant and Makeup Water Treatment System

The demineralized water makeup system is a pretreatment system designed to treat the lake water for use as filtered water, potable water, and other auxiliary uses. The filtered water is used for cooling and/or lubrication requirements of circulating water and service water pumps, and back and surface wash requirements for filters. The system is designed to upgrade water quality to the degree required for demineralized makeup water. The final effluent from the system is discharged into the demineralized water storage tank from where it is distributed, for required station usage. (EGC 2020a)

The makeup water pump house pretreating system uses up flow filtration, sand filtering, and reverse osmosis to provide filtered and potable water for station needs. The makeup water pump house also contains a mixed bed polisher system (demineralizer) utilizing off station regenerated mixed bed resin media bottles. The combination of reverse osmosis and mixed bed polishers provide a reliable supply of demineralized water for station equipment systems. (EGC 2020a)

2.2.3.9 Potable and Sanitary Water System

Potable and sanitary water is supplied from Clinton Lake. The water is treated, as required, to meet Illinois Department of Public Health (IDPH) drinking water standards. Sanitary waste from the station area is treated to meet the requirements of the NPDES permit issued by the IEPA. Sewage treatment consists of primary and secondary aerated lagoon cells. The effluent of the lagoon is normally treated by tertiary sand filtration before release to the circulating water discharge flume. This filtration ensures compliance with the NPDES permit for biochemical oxygen demand and total suspended solids. The sewage treatment system includes effluent sampling and flow measurement. (EGC 2020a)

2.2.3.10 Fire Protection System

The fire protection system is designed to provide an adequate supply of water to points throughout the station where fire protection may be required. The fire protection water is drawn from the UHS which is sized to include 900,000 gallons of water for fire protection. The fire protection system consists of two 100 percent capacity diesel-driven fire pumps (primary fire protection system water supply), one connection to the PSWS, a dedicated pressure maintenance jockey pump, and the associated piping, valves, and hydrants. (EGC 2020a)

2.2.4 Meteorological Monitoring Program

The onsite meteorological monitoring program began at CPS in 1972. The instrument systems and their locations were selected with emphasis on compliance with Regulatory Guide 1.23. A meteorological tower with two levels of instrumentation was erected. The location of the tower is shown in Figure 3.1-1. (EGC 2020a)

The meteorological measurements program at CPS consists of monitoring wind direction, wind speed, temperature, dewpoint, and precipitation. The main tower is instrumented at the 10 meter and 60-meter levels. All parameters are recorded digitally and displayed in the main control room. Data recovery is expected to exceed 90 percent for all parameters. Two methods of determining atmospheric stability are used: delta T (vertical temperature difference) is the principal method; sigma theta (standard deviation of the horizontal wind direction) is available for use when delta T is not available. These data are used to determine the meteorological conditions prevailing at the station. (EGC 2020a)

The meteorological tower is equipped with instrumentation that conforms with the system accuracy recommendations of Regulatory Guide 1.23. The equipment is placed on booms oriented into the generally prevailing wind at the station. Equipment signals are brought to an instrument shack with controlled environmental conditions. The shack at the base of the tower houses the recording equipment, signal conditioners, etc., used to process and retransmit the data to the end-point users. (EGC 2020a)

Recorded meteorological data are used to generate wind roses and provide estimates of airborne concentrations of gaseous effluents and projected offsite radiation dose. In addition to the meteorological instruments, an unused antenna for the Alert and Notification System is mounted on this tower at approximately 170 feet high. Meteorological monitoring instruments have been placed on the microwave tower to act as a backup to the existing meteorological monitoring instruments on the meteorological tower. The microwave tower is 250 feet high with instrumentation (wind speed and direction) installed at the 33-foot (10-meter) level. The current antenna for the Alert and Notification System is mounted on the microwave tower. (EGC 2020a) The location of the microwave tower can be seen in Figure 3.1-1.

The monitoring panel, located in a shelter at the base of the microwave tower, is a microprocessor-based system which is used to collect, process, format, and record all the meteorological data supplied. The data is displayed locally and is accessible for review and trending at the control building. (EGC 2020a) Regional and station meteorology, as well as air quality, are presented in detail in Section 3.3. Meteorological parameters monitored at CPS are listed in Table 2.2-1.

2.2.5 Power Transmission System

2.2.5.1 <u>In-Scope Transmission Lines</u>

Based on NRC Regulatory Guide 4.2 (NRC 2013b), transmission lines subject to evaluation of environmental impacts for license renewal are those that connect the nuclear power plant to the switchyard where electricity is fed into the regional power distribution system, and power lines that feed the plant from the grid during outages. In-scope transmission lines are further clarified in the GEIS as being those lines that would not remain energized if the plant's license were not renewed.

In-scope transmission lines that connect the station to the transmission system are those lines from the Reserve Auxiliary Transformers (RAT) to the 345-kilovolt (kV) switchyard, the main power transformers (MPTs) to the 345-kV switchyard, and the 138-kV feed to the emergency reserve auxiliary transformer (ERAT). All in-scope transmission lines are located completely within the CPS exclusion area boundary (EAB), as shown in Figure 2.2-2.

Two offsite power systems provide electrical power to the station: the 138-kV offsite power system, and the 345-kV offsite power system. The 138-kV offsite power system provides power to the station by one transmission line. This line connects the station to the Ameren Illinois Company grid at the Tabor Switching Station Ring Bus. The line terminates directly (through a circuit switcher) at the ERAT, which transforms the electrical power to 4160-V auxiliary bus voltage. (EGC 2020a) The 138-kV line also supplies power to two 138-kV/12-kV substations (supplemental cooling and auxiliary boiler (SCAB) transformer/bus and construction (CONST) transformer/bus) located approximately 150 feet from the 138-kV line. The SCAB transformer normally provides power to CPS electrode boilers and other out-building loads. (EGC 2020a) As shown in Figure 2.2-2, the in-scope portion of the 138-kV transmission line is from the ERAT to the SCAB transformer. The 138-kV line has sufficient capacity to serve the ERAT load requirements as well as station electrode boilers, station outbuildings, and the customer substation loads (EGC 2020a). The ERAT is designed to start and carry the auxiliary load required for LOCA emergencies at the unit. (EGC 2020a)

The 345-kV offsite power system provides power to the station through three transmission lines. These lines connect the station to the Ameren Illinois Company grid at Brokaw, Goose Creek-Oreana, and Oreana substations. All three lines terminate at the station switchyard ring bus which feeds RATs A, B, and C, which in turn transforms the electrical power to the 6900-V and 4160-V auxiliary bus voltages. The three RAT transformers; RAT A, RAT B, and RAT C, each have their own 345-kV manually operated disconnect switch. These switches have sufficient capability to interrupt the magnetizing current of its respective transformer after the transformer low-side bus connections have been isolated from the transformer. Remote indication of each switch position is provided in the main control room. The RATs are sized to carry the portion of auxiliary load required for the unit connected buses. In addition, RAT B is sized to carry the total coincidental auxiliary load required for LOCAs at the unit. The RATs are also sized to carry the auxiliary load required for startup of the unit. (EGC 2020a)

The 345-kV switchyard also accepts electrical power from the station main generator via the MPTs and motor operated disconnect (MOD) 4508, and gas circuit breakers (GCB) 4506 and 4510. During station outages, disconnect links may be removed at the main generator which allows MOD 4508, GCB 4506, and GCB 4510 to be shut. This configuration provides back feeding capability to the MPTs which establishes a reliable power source to the Auxiliary Power system during the outage period.

The 345-kV and 138-kV transmission lines and their associated structures are designed to successfully withstand environmental conditions prevalent in the area (for example, wind, temperature, lightning, flood, etc.), thus minimizing simultaneous failure. The 345-kV transmission lines approach the switchyard on two separate rights-of-way. The 138-kV transmission line ROW is physically separated from the ROW of the 345-kV transmission lines. The 138-kV transmission line does not enter the 345-kV switchyard. Because of this separation, failure of one line cannot cause failure of all lines. The RATs and the ERAT establish two independent circuits to the onsite electrical distribution system. (EGC 2020a)

2.2.5.2 Vegetation Management Practices

The in-scope transmission lines are completely within the CPS EAB as shown in Figure 2.2-2. The in-scope transmission lines cross the CPS industrial areas, where vegetation is sparse and need minimal vegetation management.

2.2.5.3 Avian Protection

CEG promotes protection of migratory, threatened, and endangered birds through a corporate avian and wildlife management plan. The plan provides guidance to CEG employees on how to properly respond when encountering dead or injured wildlife or the need to disturb the wildlife or its habitat. This procedure is required to maintain compliance with federal and state bird protection laws including, but not limited to, the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), and the Endangered Species Act (ESA).

CEG incorporates industry best management practices (BMPs) per guidance available through the Avian Power Line Interaction Committee, the U.S. Fish and Wildlife Service (USFWS), and benchmarking with fellow electric utilities.

2.2.5.4 Public

As presented in Section 2.2.5.1, all in-scope transmission lines are located completely within property owned by CEG. The public does not have access to this area; therefore, no induced shock hazards would exist for the public (Figure 2.2-2).

2.2.5.5 Plant Workers

NUREG-1437 suggests that occupational safety and health hazard issues are generic to all types of electricity generating stations, including nuclear power plants, and are of small significance if the workers adhere to safety standards and use protective equipment (NRC 2013a).

CEG maintains safety-specific policies for all work conducted at electrical transmission locations.

2.2.6 Radioactive Waste Management System

Radioactive waste management at CPS is accomplished through the use of three interrelated systems: gaseous radwaste system, liquid radwaste system, and solid radwaste system (EGC 2020a).

Waste handling systems have been incorporated in the station design for processing and/or retention of radioactive wastes from normal station operations, including anticipated operational occurrences, to ensure that the effluent releases to the environment are as low as reasonably achievable (ALARA) and within the limits of 10 CFR 20 and in compliance with 10 CFR 50, Appendix I. The station is also designed with provisions to prevent radioactivity releases during accidents from exceeding the limits of 10 CFR 100 or 10 CFR 50.67. (EGC 2020a)

2.2.6.1 Liquid Waste Management System

The liquid radwaste system collects, monitors, and treats liquid radioactive wastes for return to the station for reuse insofar as is practicable. The processing equipment is located in the radwaste building. Any discharge is such that concentrations and quantities of radioactive material and other contaminants are in accord with applicable local, state, and federal regulations. The station has not discharged through the liquid radwaste system since 1992. All potentially radioactive liquid wastes are collected in sumps or drain tanks at various locations in the station. These wastes are transferred to collection tanks in the radwaste facility. (EGC 2020a)

The liquid radwaste system consists of four major subsystems: (1) the equipment drain subsystem, (2) the floor drain subsystem, (3) the chemical waste subsystem, and (4) the laundry waste subsystem. (EGC 2020a)

The equipment drain subsystem collects and processes high purity (low conductivity) waste such as from equipment drains. The water is treated by settling, filtration, and/or ion exchange demineralization and returned after appropriate sampling to the cycled condensate storage tank for station reuse. Major input sources to the equipment drain subsystem include backwash from condensate filters, radwaste demineralizers, and ultrasonic resin cleaner; decant from waste sludge tank, reactor water cleanup phase separator tank, fuel pool filter/demineralizer sludge tank, and spent resin tank; and flows from equipment drain tanks and sumps in drywell containment, auxiliary, turbine, radwaste, and fuel buildings. (EGC 2020a)

The floor drain subsystem collects and processes low purity (high conductivity) waste from the Unit 1 floor drain system. These wastes are normally too high in conductivity for efficient ion exchange treatment. They may also contain a high number of suspended solids. Treatment can be by settling, evaporation, adsorption (normally for organic removal), and ion exchange demineralization for return to the condensate storage tank or for discharge from the station after appropriate sampling. Major input sources to this subsystem are wastes from the floor drain collector tanks and sumps in the following buildings: containment, turbine, auxiliary, radwaste, control, and fuel. Floor drain oil separators are used to prevent oil from entering the liquid radwaste processing stream, and thus avoiding potential problems in attaining high-quality effluent for return to condensate storage or for station discharge. Regarding the disposal of contaminated oil collected by these separators, the oil is packaged for shipment in accordance with approved station procedures. (EGC 2020a)

The chemical waste subsystem processes the highest conductivity water in the liquid radwaste system. Major types of waste processed in this subsystem include: radwaste demineralizer regenerants (if resin is regenerated), flows from decontamination drains, and flows from laboratory drains. These wastes are potentially high in radioactivity, conductivity, and suspended solids including some resin fines. Processing of these wastes is by settling, chemical neutralization, evaporation, ion exchange demineralization, and whenever practical, holdup for radioactive decay. On occasion, waste may be processed through the waste filters prior to being processed through the evaporator. (EGC 2020a)

The laundry waste subsystem receives waste from the station laundry drains, personnel decontamination showers, and any other contaminated sources that may be high in detergent content. These wastes are normally very low in radioactivity content. The system is designed to allow for complete recycling of all processed waste with return to the condensate storage system. (EGC 2020a)

The processed liquid radwaste stream terminates at three waste sample tanks. Since the liquid radwaste system operates on a batch basis, this arrangement allows each treated batch to be sampled in the respective sample tank to ensure that the treatment was effective. If the sample indicates that the waste is still contaminated beyond acceptable limits, the capability is provided to recycle the waste either through the same treatment or through another subsystem. If the treated waste sample indicates that the water quality is within limits required for recycling, it is sent to the cycled condensate storage tank for reuse. If the station water balance does not allow for recycling, the treated waste is sent to one of two excess water tanks for short-term storage. If storage capacity does not develop in the cycle condensate storage system in a reasonable period of time, as determined by the waste accumulation rate, a discharge of waste is scheduled. (EGC 2020a)

The excess water tanks discharge to the service water discharge pipe using a common line where a radiation monitor is installed. The line is connected to the service water discharge line which joins the circulating discharge water at the seal well. Circulating water then flows through the 3.4-mile discharge canal to Clinton Lake. (EGC 2020a)

2.2.6.2 Gaseous Waste Management System

The purpose of the gaseous radwaste system is to process and control the release of gaseous radioactive wastes to the station environs so the total radiation exposure to persons outside the controlled area does not exceed the maximum limits of the applicable 10 CFR 20 regulations even with some defective fuel rods. (EGC 2020a)

The off gases from the main condenser are the major source of gaseous radioactive waste. The treatment of these gases includes volume reduction through a catalytic hydrogen-oxygen recombiner, water vapor removal through a condenser, decay of short-lived radioisotopes through a holdup line, further condensation and cooling, adsorption of isotopes on activated charcoal beds, further filtration through high efficiency filters, and final releases. (EGC 2020a)

Airborne radioactive releases to the environs from the building ventilation and the off-gas system are from a single common station vent. The station vent release point is above the containment building dome which is the tallest structure in the power block. (EGC 2020a)

Continuous radiation monitors are provided which indicate radioactive release from the reactor and from the charcoal adsorbers. The radiation monitors are used to isolate the off-gas system on high radioactivity in order to prevent releasing gases of unacceptably high activity. (EGC 2020a)

2.2.6.3 Solid Waste Management System

The objectives of the solid waste management system are as follows (EGC 2020a):

The solid radwaste system serves to collect, hold for decay, monitor, package, and temporarily store all wet and dry solid radioactive wastes produced by the station during operation and maintenance prior to offsite shipment. The system is divided into four subsystems: wet solid waste, wet solid waste packaging and handling, mobile solidification station, and dry solid waste packaging. (EGC 2020a)

The wet solid waste subsystem consists of a group of tanks and associated pumps which serve as an interface between the liquid radwaste system and the mobile solidification station. These tanks provide intermediate storage for slurries produced by radwaste processing equipment or other radioactive water cleanup systems. A plug-type divert valve is provided in the recirculation line near the mobile solidification station to enable the waste to be metered to the mobile solidification equipment or recirculated to the tank of origin. Automatic flushing sequences are provided for the recirculation line and the interfacing transfer line. (EGC 2020a)

The mobile solidification station consists of concentrated waste, sludge, and resin waste transfer lines with isolation valves upstream of flat flanges. These flanges serve as interface connections to mobile solidification or dewatering/drying processing equipment via a manifold and flexible hoses. (EGC 2020a) The mobile solidification or dewatering/drying system is designed to package radioactive solid waste for offsite shipment and subsequent burial in accordance with applicable NRC 10 CFR 61 and 10 CFR 71 and U.S. Department of Transportation (USDOT) 49 CFR 170-178 regulations. (EGC 2020a)

Dry active waste is sorted and loaded in packages. Offsite processing services are used to support the disposal of dry active waste. Materials are prepared according to regulations for transportation of radioactive material [10 CFR Part 71 and 49 CFR Parts 171-178] and per acceptance criteria referenced in the contracts with the processing vendors. The packages are normally filled and then moved to temporary storage outside the station within the protected area (PA) either at the northwest corner of the turbine building in the gravel and asphalt area or the southeast corner of the PA. (EGC 2020a)

Handling and packaging of large waste materials is considered on a case-by-case basis depending on the specific waste material characteristics. Decontamination, packaging, and storage is accomplished as required. Waste processing alternatives which surpass the station's current capabilities would be used as necessary to supplement the station capabilities. (EGC 2020a)

Containers normally can be shipped as soon as solidification of dewatered/dried waste is complete, provided the proper shielding is available, without exceeding USDOT radiation limits. Shipment of solid or dewatered/dried waste from the station would only be by licensed carriers and would be limited to shipment to licensed commercial or federal waste repositories or licensed secondary processors for additional processing. (EGC 2020a)

2.2.6.4 Spent Nuclear Fuel

Storage space for spent fuel is provided at the onsite independent spent fuel storage installation (ISFSI), in the fuel building spent fuel pool, and in the upper containment fuel storage pool (as well as in the cask storage pool when it is utilized to hold two storage racks to extend core offload capacity). The fuel building spent fuel storage pool contains sufficient storage space for approximately 400 percent of one full core fuel load. The fuel building cask storage may be utilized on an as-needed basis (to extend core offload capacity) for storage of up to two spent fuel storage racks for approximately 42 percent of one full core fuel load. The upper containment fuel storage pool, which would be used for storage of spent fuel only during refueling operations, contains sufficient storage space for approximately 25 percent of one full core fuel load. (EGC 2020a)

CEG has selected the Holtec International Storage Module Flood/Wind System (HI-STORM FW System), for storage of spent fuel in the CPS ISFSI. The HI-STORM FW System is composed of a multi-purpose canister (MPC-89), a HI-TRAC variable weight transfer cask, and HI-STORM FW overpack. The CPS ISFSI is located within the PA of the station. (EGC 2020a) The station currently has 18 MPC-89s on the ISFSI pad with the capacity for 18 additional canisters. It is anticipated that the CPS ISFSI may need to be expanded during the LR period of extended operation (PEO) if the U.S. Department of Energy (DOE) has not taken ownership of the spent nuclear fuel (SNF) prior to the ISFSI reaching capacity. It is expected that there is enough previously disturbed land area available for this expansion within the site boundary. Spent fuel dry cask storage operations at CPS are conducted under a general license in accordance with Subpart K of 10 CFR 72. (EGC 2020a)

2.2.6.5 Ultimate Disposal Operations

CPS uses a process control program to establish the process and boundary conditions for the preparation of specific procedures for processing, sampling, analysis, packaging, storage, and shipment of solid radwaste in accordance with local, state, and federal requirements.

The program establishes parameters which provide reasonable assurance that all low-level radioactive wastes (LLRW), processed by the in-station waste process systems on site or by onsite vendor supplied waste processing systems, meet the acceptance criteria to a licensed burial facility, as required by 10 CFR 20, 10 CFR 61, 10 CFR 71, and 49 CFR 171-12, as applicable. The program also provides reasonable assurance that waste placed in "on-site storage" meets requirements as addressed with the Safety Analysis Reports for the LLRW storage facilities for dry and/or processed wet waste.

CPS has contracts with Energy Solutions and Waste Control Specialists for the processing and disposal of all radiologically contaminated material. CPS has previously, within the last 5 years, held a contract with Perma-Fix. Amount and types of radioactive waste are reported annually to the NRC via the annual radiological effluent release report.

LLRW is classified as Class A, Class B, or greater-than-Class C. Class A includes both dry active waste and processed waste (e.g., dewatered resins). Class B and C normally include processed waste and irradiated components. Class B and C wastes constitute a low percentage by volume of the LLRW generated and can be stored within the radwaste building in collection tanks until it is ready to go to the vendor. Disposal of greater-than-Class C waste is the responsibility of the federal government.

CPS does not currently generate or store mixed waste on site.

2.2.7 Nonradioactive Waste Management System

The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid waste. The Illinois Environmental Protection Agency (IEPA) Bureau of Land Permit Section is authorized by the U.S. Environmental Protection Agency (EPA) to implement the RCRA in Illinois.

CPS generates nonradioactive waste as a result of station maintenance, cleaning, and operational processes that occur at the station. Table 2.2-2 provides the amount of nonradioactive hazardous, nonhazardous, and recycled wastes generated at CPS from 2018-2022.

CPS is classified by the EPA as a small quantity generator (SQG) of hazardous and universal waste. CEG maintains a list of approved waste vendors used to manage and dispose of hazardous, nonhazardous, and recyclable waste. As an SQG, CPS is to make a good faith effort to minimize hazardous waste generation and practices waste minimization as certified on its hazardous waste shipping manifests. CEG has a fleet procedure for hazardous waste minimization. The procedure requires each plant to track its regulated waste (e.g., hazardous waste and universal waste) and annually review station waste generation for trends or opportunities for waste reduction. Waste minimization approaches included in the procedure and implemented as appropriate include utilizing inventory controls for chemicals and review of chemicals for nonhazardous substitutes, applying operation and maintenance procedures and implementing efficiency improvement where appropriate to reduce waste generation, reducing waste volumes by such means as source segregation, recovery of waste materials/metals where possible by such means as solvent filtration and scrap metal sales, and recycling waste such as ink and toner cartridges and other office waste where possible.

Table 2.2-1 Meteorological Parameters

Parameter	Tower (Elevation Level)
Precipitation (inches)	1 meter
Wind Speed (mph)	10 meters, 60 meters
Sigma Theta (deg)	10 meters, 60 meters
Wind Direction (deg)	10 meters, 60 meters
Temperature (°F)	10 meters, 60 meters
Dew Point (°F)	10 meters
Delta T (°F)	10 meters, 60 meters

Table 2.2-2 CPS Nonradioactive Waste Types 2018–2022

Year	Hazardous Waste Generated	Nonhazardous Waste Generated	Total Recycled
2018	685 kg	131,049 kg	128,639 kg
2019	1,678 kg	238,659 kg	406,235 kg
2020	372 kg	87,277 kg	58,236 kg
2021	273 kg	54,402 kg	49,479 kg
2022	345 kg	11,108 kg	7,793 kg

kg = kilogram

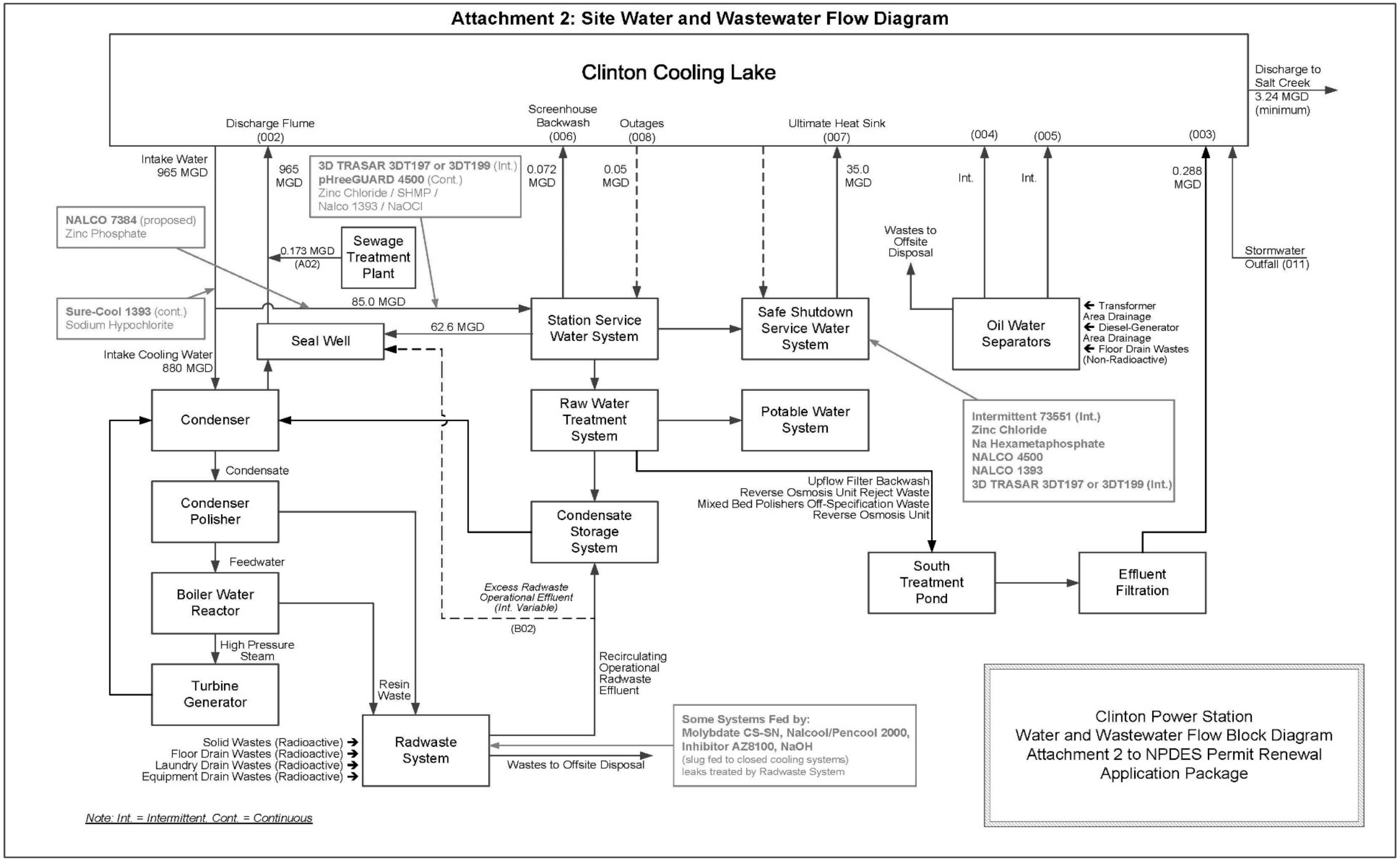


Figure 2.2-1 CPS Water Balance

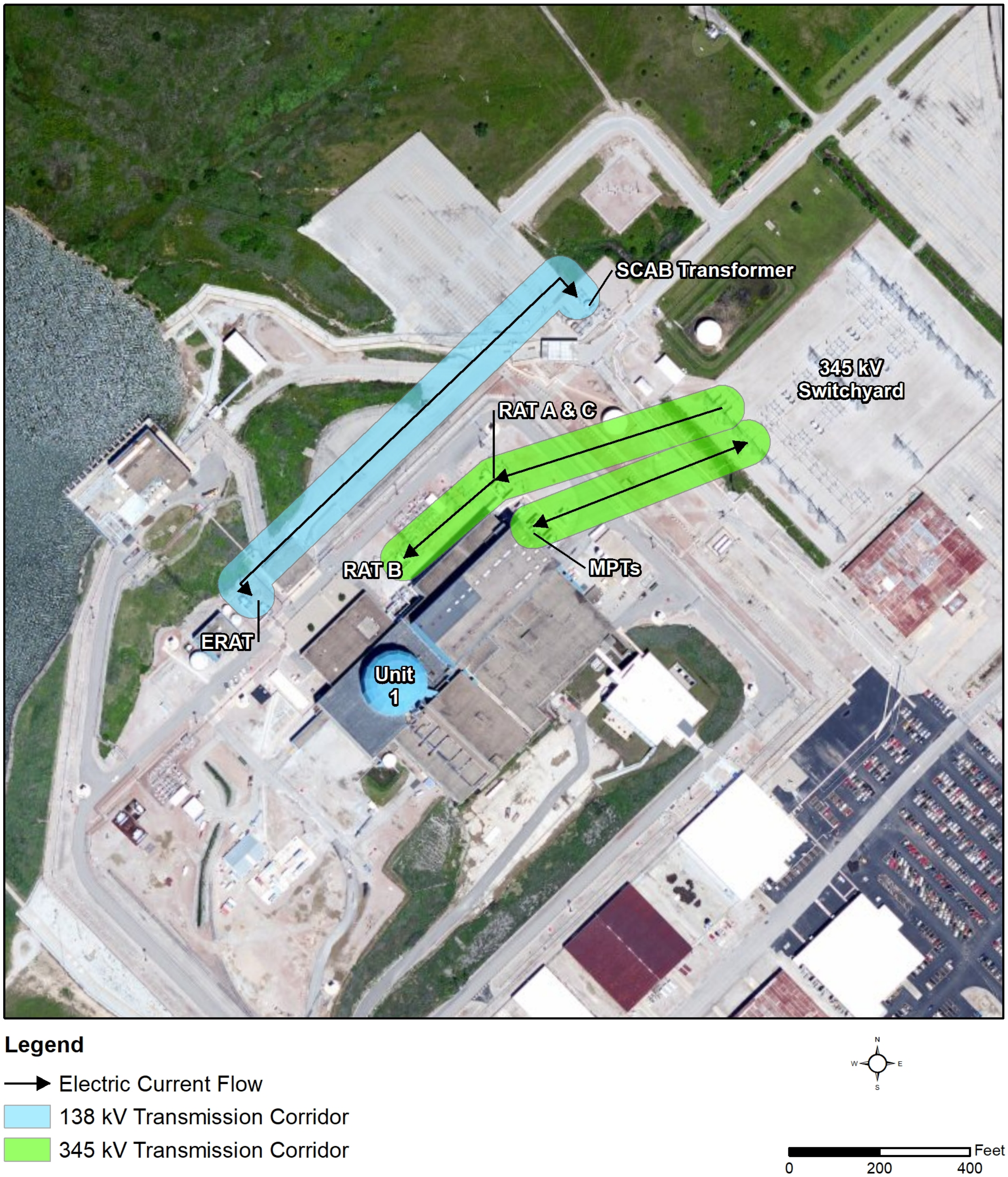


Figure 2.2-2 In-Scope Transmission Lines

2.3 Refurbishment Activities

In accordance with 10 CFR 51.53(c)(2), a LR applicant's ER must contain a description of the applicant's plan to modify the facility or its administrative control procedures as described in accordance with § 54.21. If LR-related refurbishment is planned at a facility, the applicant's ER would include analysis for environmental impacts of the proposed refurbishment activity [10 CFR 51.53(c)(3)(ii)].

The incremental aging management activities implemented to allow operation of a nuclear power plant during a renewal term are assumed to fall under one of two broad categories. One of these categories involves refurbishment actions, which usually occur infrequently, and possibly only once in the life of the plant, for any given item. The other category is SMITTR actions, most of which are repeated at regular intervals and schedules. (NRC 2013a)

The NRC requirements for the renewal of OLs for nuclear power plants include preparation of an IPA [10 CFR 54.21]. The IPA must identify SSCs subject to aging management review. The objective of the IPA is to determine whether the detrimental effects of aging could preclude certain SSCs from performing in accordance with the current licensing basis during the additional 20 years of operation requested in the license renewal application (LRA). An example of an SSC subject to aging is the reactor vessel.

The CPS IPA, which CEG conducted under 10 CFR Part 54, which is described in the body of the LRA, has identified no LR-related refurbishment or replacement actions needed to maintain the functionality of SSCs, consistent with the current licensing basis, during the proposed LR term. CEG does not anticipate the continued operation of CPS to result in any environmental impact greater than SMALL.

2.4 Programs and Activities for Managing the Effects of Aging

In accordance with 10 CFR 51.53(c)(2), a LR applicant's ER must contain a description of the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21. This report must describe in detail the modifications directly affecting the environment or any station effluents.

The programs for managing the effects of aging on certain structures and components within the scope of LR at the station are described in the LR (see Appendix B of the CPS LRA). The evaluation of structures and components required by 10 CFR 54.21 identified the activities necessary to manage the effects of aging on structures and components during the proposed LR term.

2.5 Employment

The non-outage workforce at CPS consists of approximately 596 employees, including 549 permanent full-time employees and an additional 47 long-term contract workers who support station operations. Approximately 70 percent of the employees reside in McLean, DeWitt, and Macon counties (28 percent, 22 percent, and 20 percent respectively), with the remaining 30 percent residing in various other locations. Table 2.5-1 summarizes the residential distribution of CPS permanent full-time employees. Overall station staffing levels are representative of those expected during the proposed license renewal operating term as there are no plans to add additional permanent employees to support station operations. As noted in Section 2.3, no LR-related refurbishment activities have been identified and there are no plans to add additional permanent operation staff to support SMITTR activities during the proposed LR term.

During refueling outages, which last approximately 19 days on a 24-month cycle, there are typically an additional 1,097 contract employees on site.

Table 2.5-1 CPS Employee Residence Information, September 2022 (Sheet 1 of 4)

State	County	City/Town	Full-Time Employees
Alabama (1)	Lauderdale (1)	Waterloo	1
Georgia (1)	Fulton (1)	Atlanta	1
Iowa (1)	Scott (1)	Bettendorf	1
Illinois (534)	Champaign (54)	Champaign	19
		Dewey	1
		Fisher	1
		Mahomet	19
		Penfield	1
		Saint Joseph	1
		Savoy	5
		Tolono	1
		Urbana	6
	Christian (3)	Mount Auburn	1
		Pana	2
	Cook (4)	Chicago	1
		Hoffman Estates	1
		Homewood	1
		Tinley Park	1
	DeWitt (120)	Clinton	89
		Dewitt	5
		Farmer City	9
		Kenney	1
		Lane	1
		Wapella	8
		Waynesville	2
		Weldon	5
	Douglas (1)	Villa Grove	1
	DuPage (2)	Burr Ridge	1
		Lombard	1
	Ford (2)	Gibson City	2
	Fulton (2)	Atlanta	2
	Grundy (1)	Morris	1
	Jo Daviess (1)	Gardner	1
	Kane (1)	Aurora	1
	Kankakee (2)	Bradley	1

Table 2.5-1 CPS Employee Residence Information, September 2022 (Sheet 2 of 4)

State	County	City/Town	Full-Time Employees
		Kankakee	1
	Kendall (1)	Oswego	1
	La Salle (1)	Streator	1
	Lee (1)	Dixon	1
	Livingston (2)	Cullom	1
		Dwight	1
	Logan (22)	Beason	1
		Lincoln	20
		Mount Pulaski	1
	Macon (112)	Argenta	5
		Boody	1
		Decatur	62
		Forsyth	16
		Maroa	16
		Mount Zion	5
		Oakley	2
		Oreana	5
	Marshall (1)	Varna	1
	Mason (2)	Manito	1
		Mason City	1
	McLean (151)	Bloomington	105
		Carlock	2
		Chenoa	1
		Colfax	1
		Downs	2
		Ellsworth	1
		Heyworth	7
		Le Roy	4
		Mclean	2
		Merna	1
		Normal	20
		Saybrook	2
		Stanford	1
		Towanda	2
	Moultrie (3)	Bethany	1
		Sullivan	2

Table 2.5-1 CPS Employee Residence Information, September 2022 (Sheet 3 of 4)

State	County	City/Town	Full-Time Employees
	Ogle (1)	Byron	1
	Peoria (2)	Peoria	2
	Perry (1)	Pinckneyville	1
	Piatt (15)	Bement	1
		Cerro Gordo	1
		Cisco	1
		La Place	1
		Mansfield	2
		Monticello	9
	Sangamon (9)	Illiopolis	1
		Riverton	1
		Rochester	1
		Springfield	5
		Williamsville	1
	Shelby (4)	Cowden	1
		Findlay	1
		Moweaqua	2
	Tazewell (6)	Delavan	1
		East Peoria	2
		Mackinaw	1
		Minier	1
		Pekin	1
	Vermilion (2)	Danville	1
		Oakwood	1
	Wayne (1)	Fairfield	1
	Will (4)	Bolingbrook	1
		Channahon	1
		New Lenox	1
		Plainfield	1
Indiana (2)	Allen (1)	Greenwood	1
	Hamilton (1)	Fort Wayne	1
Michigan (1)	Lapeer (1)	Lapeer	1
MO (1)	Saint Louis (1)	Hazelwood	1
North Carolina (2)	Craven (1)	New Bern	1
	Onslow (1)	Camp Lejeune	1
New York (1)	Orange (1)	Chester	1

Table 2.5-1 CPS Employee Residence Information, September 2022 (Sheet 4 of 4)

State	County	City/Town	Full-Time Employees
Ohio (1)	Delaware (1)	Galena	1
Pennsylvania (2)	Allegheny (1)	Glenshaw	1
	Dauphin (1)	Grantville	1
Texas (1)	Fort Bend (1)	Richmond	1
Wisconsin	Dane (1)	Waunakee	1
		Grand Total	**549**

(USCB 2020a; USDOT 2022a)

Note: CPS employee place of residence information is for permanent full-time staff and does not include a breakdown for supplemental staff, nor temporary refueling outage workers. Long-term contract staff settlement patterns are assumed to generally follow the county settlement patterns indicated by the permanent CPS staff.

2.6 Alternatives to the Proposed Action

The proposed action as described in Section 2.1 is for the NRC to renew the CPS OL for an additional 20 years. Because the NRC decision is to renew or not renew the existing CPS OL, the only fundamental alternative to the proposed action is the no-action alternative, which would result in the NRC not renewing the CPS OL. CPS is one of 11 nuclear generating reactors in Illinois and 51.8 percent of the electricity produced in Illinois comes from nuclear generation (EIA 2022a; NRC 2022a). CPS provides a significant contribution to the long-term baseload capacity in Illinois. It is reasonable to assume that the decision not to renew the CPS license would involve replacement of its 1,080 MWe (net) of generation. CEG has considered a range of replacement power alternatives from which to select the alternatives to be further analyzed for replacement of CPS baseload power generation.

2.6.1 Alternatives Evaluation Process

CEG developed the following set of evaluation criteria to review CPS replacement alternatives:

- Alternatives evaluated in this ER would need to be capable of providing 1,080 MWe net.
- Alternatives evaluated in this ER would need to provide adequate levels of baseload generation for reliable electricity availability to maintain power grid supply and reliability.
- Alternatives considered must be fully operational by April 17, 2027, when CPS's OL expires, considering development of the technology, permitting, construction of the facilities, and connection to the grid.
- Alternatives must be electricity-generating sources that are technically feasible and commercially viable.

2.6.2 Alternatives Considered

Using a screening process based on the above criteria, CEG considered the full range of alternatives considered in the GEIS in light of the need to meet the criteria.

The following generation sources were selected as reasonable replacement alternatives based on capability to provide reliable baseload power:

1. Natural Gas Alternative
    a. Natural gas combined cycle (NGCC) plant using MDCTs located on site.
2. Combination Alternative
    a. NGCC plant using MDCTs located on site.
    b. Wind turbines with battery storage located on site.
    c. Solar panel installation with battery storage located on site.

3. Purchased Power Alternative
    a. Import of power to replace CPS net power generation through long-term power-purchase agreements from renewable sources in accordance with the Illinois Power Agency Act as amended by the Illinois Climate and Equitable Jobs Act (CEJA).

A detailed discussion of the reasonable replacement alternatives is presented in Section 7.2.1.

CEG determined the following generating alternatives were not considered reasonable replacements in comparison to renewal of the CPS OL. Wind and solar are included in the list as unreasonable as discrete alternatives but are components of the combination alternative identified above.

- Plant reactivation or extended service life
- Conservation and energy efficiency measures
- Wind
- Solar
- Geothermal
- Hydropower
- Biomass
- Fuel cells
- Ocean wave and current energy
- Oil-fired plants
- Coal-fired plants

The alternatives not selected as reliable baseload generation for replacing the CPS generation are presented in Section 7.2.2. Alternatives for reducing environmental impacts are addressed in Section 7.3.

3.0 AFFECTED ENVIRONMENT

CPS Unit 1 is owned and operated by CEG. CPS is located in rural DeWitt County, Illinois, in the irregular U-shaped bend of the manmade cooling reservoir, Clinton Lake (EGC 2020a). Property within the site boundary comprises approximately 13,626 acres. However, five exception areas within this site boundary are not owned by CEG. Therefore, the total property owned by CEG is approximately 13,531 acres.

3.1 Location and Features

CPS is approximately 60 miles northeast of Springfield, equidistant between the cities of Decatur to the south, Champaign to the east, Bloomington to the north, and Lincoln to the west, at longitude 88° 50' 3" W and latitude 40° 10' 19" N (Figure 3.1-4). Most of the site is located in the eastern half of DeWitt County, roughly equidistant between St. Louis and Chicago. As shown in Figure 3.1-3, the size of the site places it in several townships: Harp, Wilson, Rutledge, DeWitt, Creek, Nixon, and Santa Anna. (EGC 2020a) Figure 3.1-1 shows the CPS site boundary, facility structures, switchyard, and the EAB. Topographic features adjacent to CPS and within the site boundary are shown in Figure 3.1-2.

3.1.1 Vicinity and Region

The vicinity of CPS is defined as the area within a 6-mile radius of the Unit 1 reactor center point. As seen in Figure 3.1-3, along with Clinton Lake, the vicinity includes DeWitt County, the villages of DeWitt and Weldon, and the community of Lane. The remainder consists primarily of woodlands, pastureland, cultivated farmland, and recreational areas (EGC 2020a). DeWitt County is not located within any statistical area, as defined by the U.S. Census Bureau (USCB) (USCB 2020b). As shown in Table 3.11-2, DeWitt County's 2020 population count was 15,516, a decrease from 16,561 in 2010.

Table 3.11-1 provides a list of communities located within a 50-mile radius of CPS. The city of Clinton is the largest city in DeWitt County and is located approximately 7 miles west of CPS. The nearest community to CPS is the village of DeWitt, approximately 3 miles east-northeast of the site in DeWitt County. In 2020, the village of DeWitt had a population count of 160, a slight decrease from 184 in 2010. (USCB 2020c)

The region of CPS is defined as the area within a 50-mile radius of the Unit 1 reactor center point. As seen in Figure 3.1-4 and described in Table 3.11-2, all or parts of 20 counties are located within the 50-mile radius of CPS, all within Illinois. The highest population by county in the region is Champaign County, Illinois, which had a population count of 205,865 in 2020 (USCB 2020d). As of 2020, Springfield, Illinois, was the only city within the 50-mile region with a population of over 100,000 persons (Table 3.11-1). Along with Springfield, there are six Illinois communities in the region with a population of over 25,000. These are the cities of Bloomington, Champaign, Decatur, Normal, Pekin, and Urbana. (USCB 2020c)

As seen in Figure 3.1-3 and Figure 3.1-4, Clinton Lake is the predominant physical feature in the region. The area surrounding CPS is not heavily industrialized, but there are two industrial facilities nearby which regularly manufacture, use, or store hazardous material: Van Horn–DeWitt, which stores agricultural chemicals, and Evergreen FS, which maintains a large propane tank. There are five pipelines that traverse the site. (EGC 2020a)

As discussed in Section 3.9.6, Illinois Route 54 (IL 54) provides commuter access to the station from the north and traverses the area southwest towards Springfield, Illinois, and northeast to Onarga, Illinois, where it merges with Interstate 57 (I-57). Access and egress to the site by road is limited by Clinton Lake, which encloses CPS to the east, south, and west. Commuters from the northwest would exit directly onto Power Road before merging with DeWitt Road, which provides direct access to the station. Also providing access to the station is Wren Road, which runs parallel to Power Road and intersects with DeWitt Road to the south and IL 54 to the north, providing commuters from the northeast with station access. Commuters from the south would take IL 10, which traverses the area from Champaign, Illinois, east of the station to Lincoln, Illinois, west. Commuters would then turn north onto Friends Creek Road to cross Clinton Lake before turning east onto Old Clinton Road/DeWitt Road. Travelers would take a hard left to stay on DeWitt Road, which provides direct access to the station from the east.

There is no commercial traffic on Clinton Lake or on either Salt Creek or North Fort Creek, the two waterways that create Clinton Lake, though there is some recreational boating and a marina on Clinton Lake (Section 3.9.7). There is one railroad within 5 miles of CPS. The Canadian National/Illinois Central Railroad runs parallel to State Route 54 and traverses the property approximately three-quarters of a mile north of the CPS center point. (EGC 2020a) While there is rail service in the region, there is no rail system providing passenger service to the CPS vicinity (Amtrak 2022). A private rail spur from the Canadian National/Illinois Central Railroad track, which is located to the north of the site boundary, was constructed to the station. With the exception of the single township road, there are no other public highways, waterways, or railroads that traverse the exclusion area. (EGC 2020a)

In addition to the CPS Heliport, there are five airfields within approximately 10 miles of the station: Sugar Hollow Airport, John Scharff Airport, Martin Airport, Thorp Airport, and Flying Illini Airport. Central Illinois Regional Airport is the closest public, full-service airport, located approximately 22 miles north-northwest of CPS. (AirNav 2022)

3.1.2 Station Features

Outside of the station, the site and its environs consist primarily of the entirety of Clinton Lake, woodlands, pastureland, cultivated farmland, and Clinton Lake recreational areas. The exclusion area is located entirely within the station represented by a circle with a 975-meter radius centered on the CPS standby gas treatment system vent (Figure 3.1-1). CEG owns all of the property in the exclusion area with the exception of a ROW for township roads (DeWitt and Wren Roads) which traverse the exclusion area. These roads (shown in Figure 3.1-1) provide access to privately-owned property which lies outside the exclusion area to the southwest. In an emergency, CEG together with the local law enforcement agency (DeWitt County Sheriff's Department) would control access via these roads to the exclusion area. The property ownership and ownership of the mineral rights provide CEG the authority to determine all activities, including exclusion and removal of personnel and property from the exclusion area. The primary activities in the exclusion area are those associated with the generation and distribution of electricity by CPS. There are no residences in the exclusion area. (EGC 2020a) The nearest residence is located approximately 1.2 kilometers southwest of the CPS HVAC vent stack (CEG 2023a).

3.1.3 Federal, Native American, State, and Local Lands

There are a variety of state and local parks, wildlife management areas, designated state forests, and recreational trail systems located in the CPS 6-mile vicinity (Figure 3.1-5) and 50-mile region (Figure 3.1-6), including the Moraine View State Recreational Area, Robert Allerton Park, Shelbyville Lake, Eagle Creek State Recreation Area, and Sangchris Lake State Resource Area. As described in Table 3.1-1 and discussed in Section 3.9.7, there are three public use lands within the 6-mile vicinity of CPS, including Clinton Lake State Recreation Area (closest to CPS), Birkbeck State Habitat Area, and Weldon Springs State Park.

There are no listed federal- or state-recognized American Indian tribes in the CPS region. Additionally, there are no American Indian-owned lands within the region. (BIA 2022; NCSL 2023). The Capital Airport Air National Guard Station is located in the region in Springfield, Illinois, approximately 50 miles from the CPS center point (NG 2022). No other military installations were identified in this region.

3.1.4 Federal and Non-Federal Related Project Activities

There are no current projects with an environmental interface, nor are there any planned or anticipated for the near future at CPS. No major changes to CPS operations, refurbishment, or plans for future expansion of station infrastructure during the proposed LR term are anticipated.

A wind energy system facility, Alta Farms Wind Project II, is currently under construction in DeWitt County approximately 9 miles west of CPS. The project covers approximately 12,000 acres. The project expects to create $44 million in local tax revenue over the next 25 years. The completion date is unknown. (EGP 2022; WP 2023)

The ISFSI pad has sufficient storage capacity for an additional 12 years, meaning it is adequate for the current license, which expires in 2027. It is anticipated that the CPS ISFSI may need to be expanded during the LR PEO if the DOE has not taken ownership of the SNF prior to the ISFSI reaching capacity. It is expected that there is enough previously disturbed land area available for this expansion within the site boundary.

Table 3.1-1 Federal, State, and Local Lands Totally or Partially Within a 6-Mile Radius of CPS

Land[a]	Type	County
Birkbeck State Habitat Area	State	DeWitt
Clinton Lake State Recreation Area	Private[b]	DeWitt
Weldon Springs State Park	State	DeWitt

(IDNR 2022a, IDNR 2022b; NPS 2022a)

a. Table list is based on available public information and includes lands totally or partially located within a 6-mile radius of CPS.

b. Clinton Lake State Recreation Area is owned by CEG but managed by the Illinois Department of Natural Resources (IDNR).

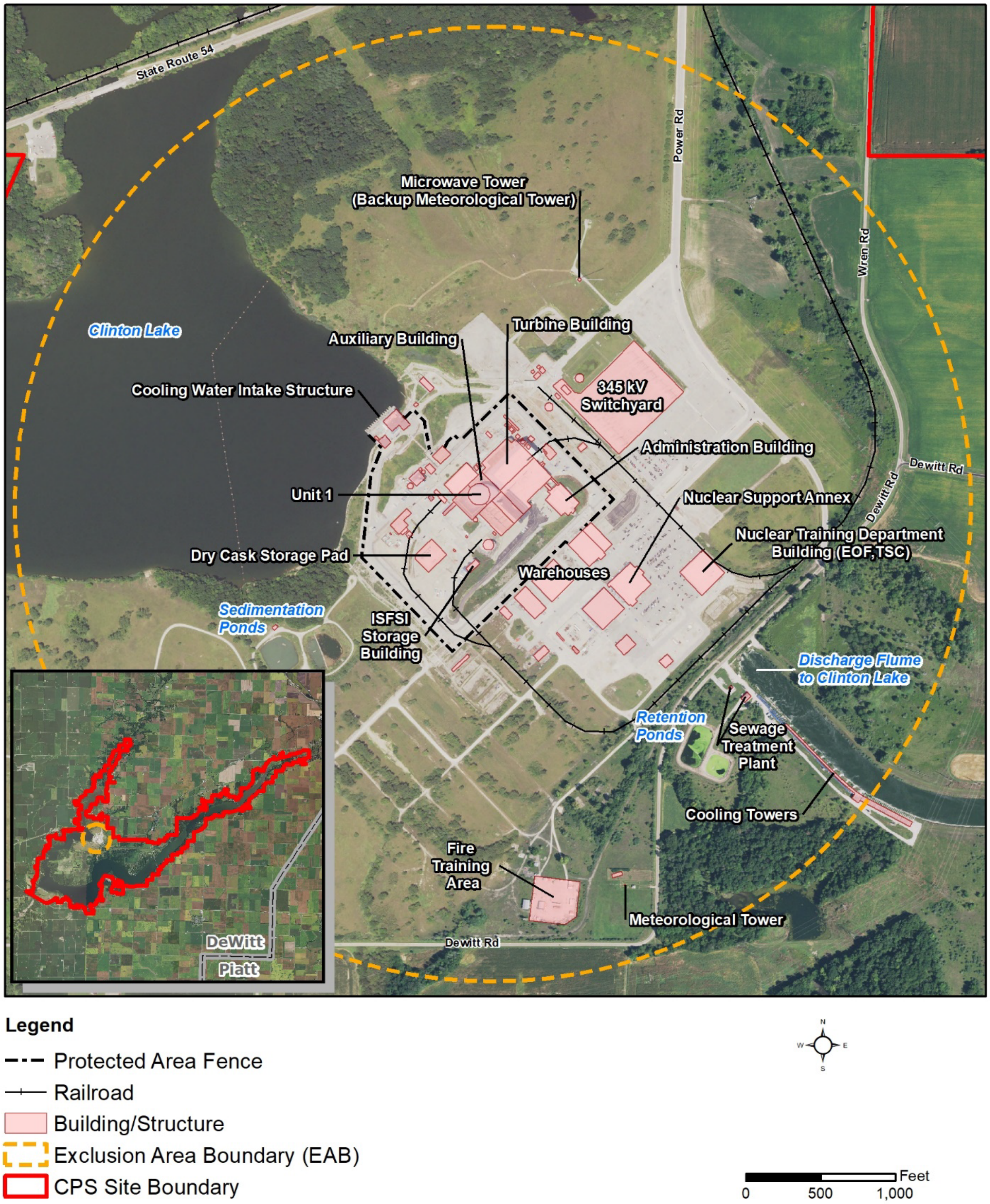


Figure 3.1-1 CPS Layout

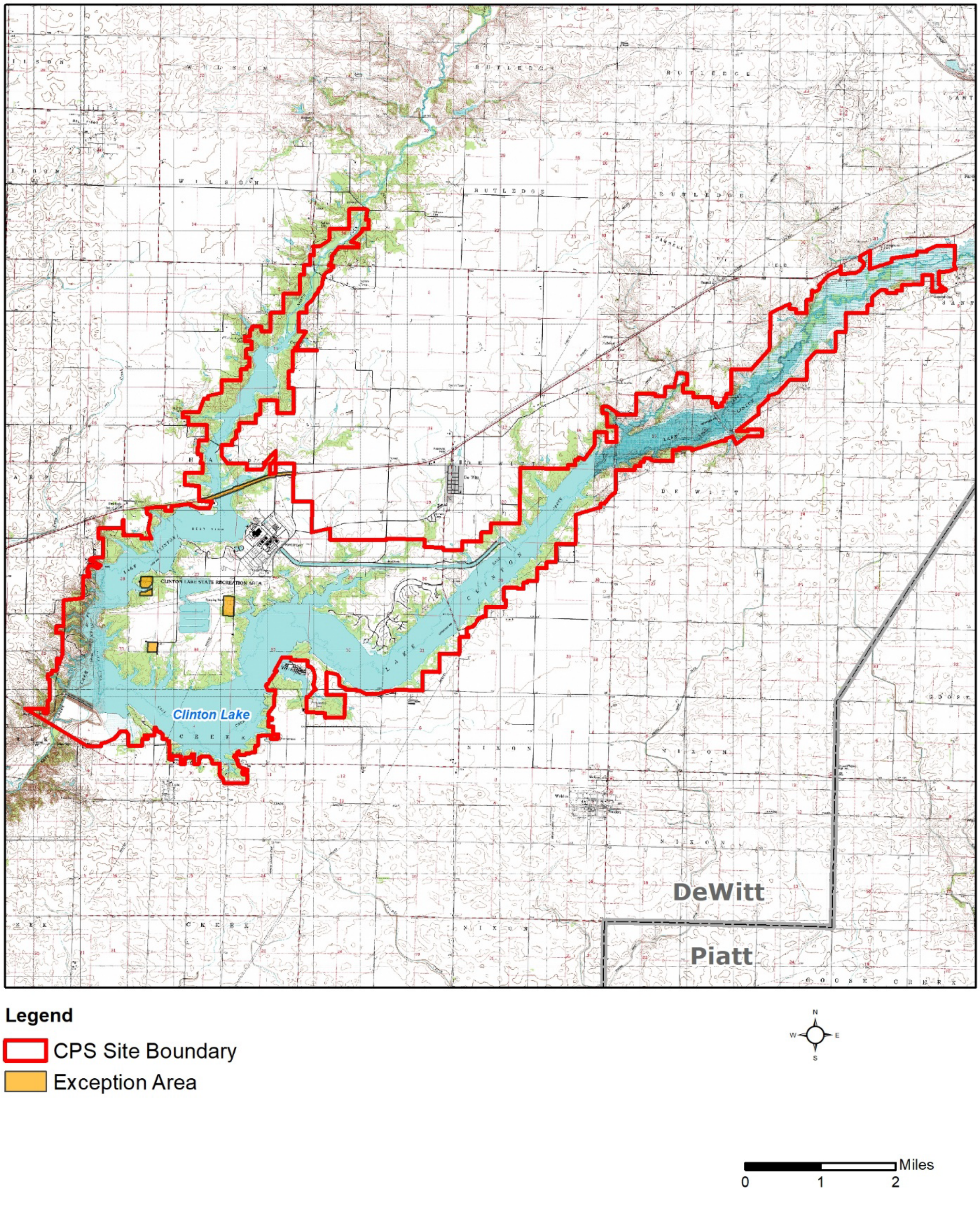


Figure 3.1-2 CPS Area Topography

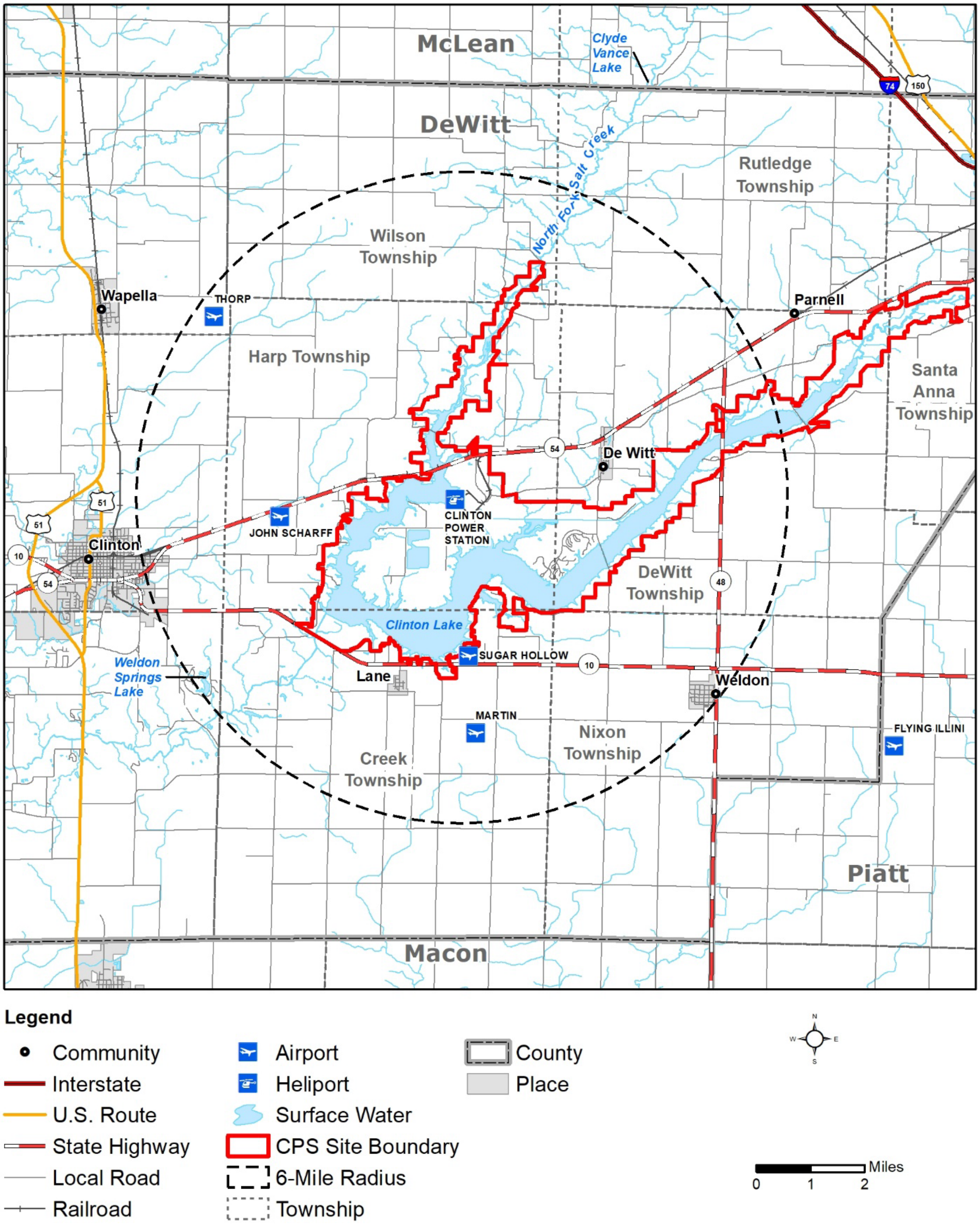


Figure 3.1-3 CPS Site and 6-Mile Radius

Figure 3.1-4 CPS Site and 50-Mile Radius

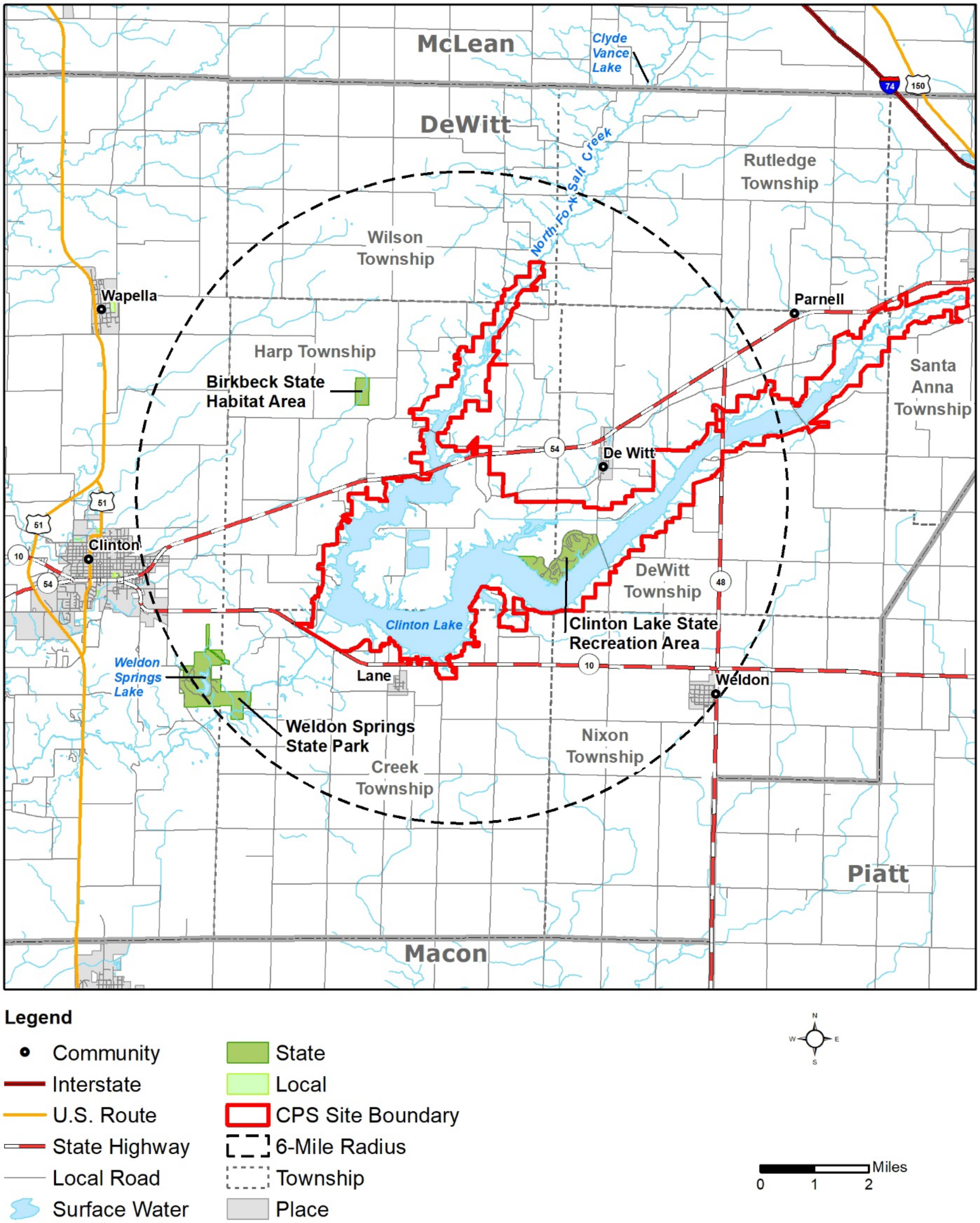


Figure 3.1-5 Federal, State, and Local Lands within a 6-Mile Radius of CPS

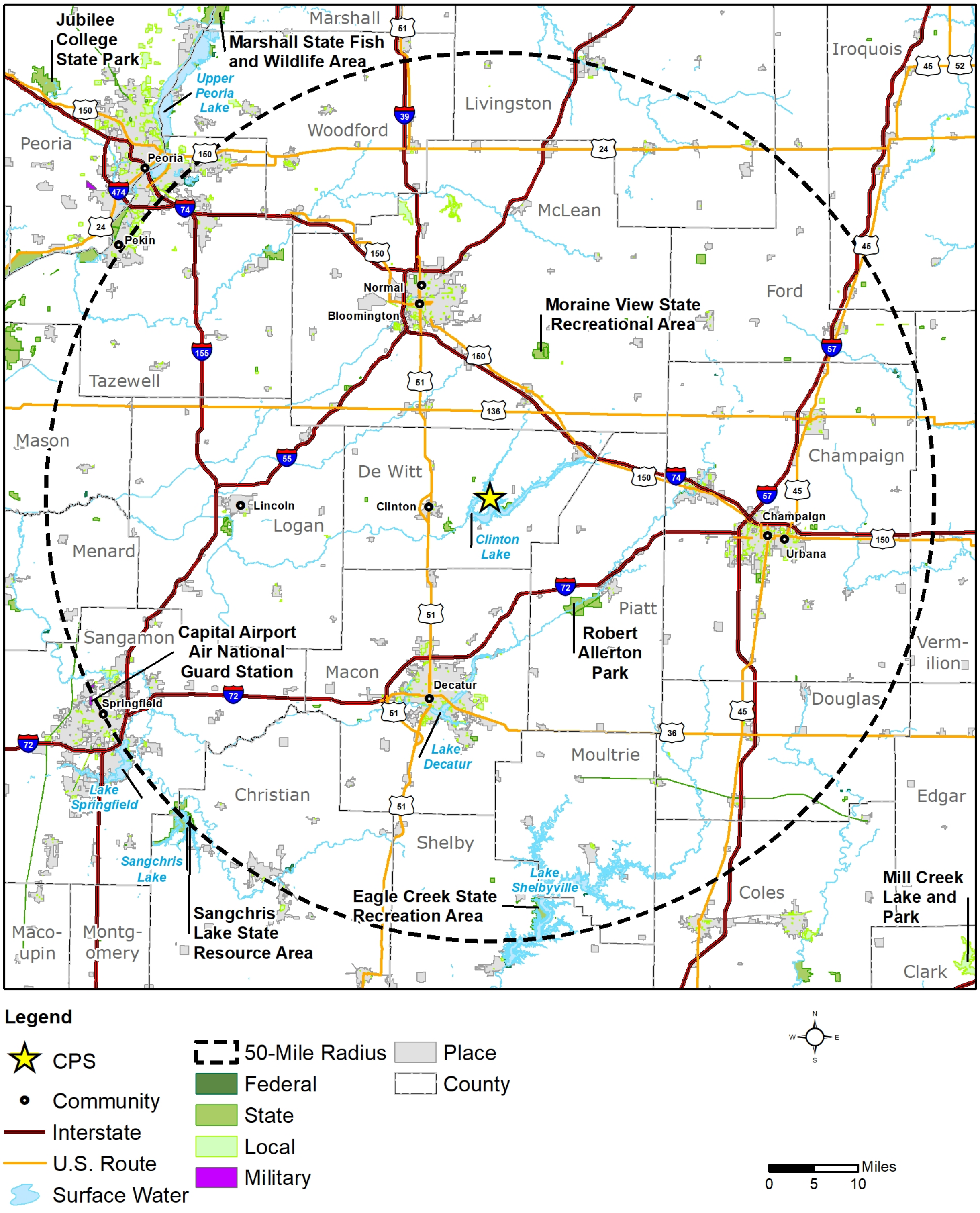


Figure 3.1-6 Federal, State, and Local Lands within a 50-Mile Radius of CPS

3.2 Land Use and Visual Resources

Land use descriptions focus on McLean, DeWitt, and Macon Counties, Illinois, because as described in Section 2.5, approximately 70 percent of the permanent CPS workforce resides in these counties, and because CPS pays taxes to DeWitt County.

3.2.1 Onsite Land Use

As described in Section 3.1, CPS is located along the cooling reservoir Clinton Lake in rural DeWitt County, Illinois. Most of the site is in the eastern half of DeWitt County, roughly equidistant between St. Louis and Chicago.

The CPS site consists of approximately 13,626 acres and encompasses Clinton Lake. CEG owns approximately 13,531 acres within the site boundary, with approximately 95 acres accounted for as five property exception areas, as shown in Figure 3.1-2. These exception areas include two farms, the Lisenby Cemetery, the former Buckeye Pipeline pumping station, and State Route 54 and adjacent railroad line. There are six active land leases within the CPS site boundary which include three agricultural crops and pastureland leases totaling approximately 895.9 acres, one private residential lease for approximately 1.9 acres, one 56-square-foot utility lease for a cell tower, and a lake lease agreement between the IDNR and the station. The lake lease includes Clinton Lake and associated property for conservation and public recreational uses and Clinton Lake State Recreation Area. CEG anticipates the renewal and continuation of these land leases through the proposed LR operating term.

As shown in Table 3.2-1 and illustrated in Figure 3.2-1, open water is the largest land use/land cover category within the CPS site boundary and is primarily associated with Clinton Lake, covering approximately 36.1 percent of the site. Deciduous forest is the next largest land use/land cover category accounting for approximately 22.5 percent of the site, followed by cultivated crops and mixed forest categories with 12.3 and 10.8 percent respectively. The remaining eight land use/land cover categories account for approximately 18.3 percent of the site. (MRLC 2019)

The DeWitt County Board adopted zoning regulations August 8, 1972, in order to promote and protect the public health, safety, comfort and general welfare of the people (DC 2018). The power generating portion of the CPS site, which includes associated facilities, is zoned as a General Industrial District (I) according to DeWitt County, Illinois, Code of Ordinances, Chapter 155: Zoning (ALP 2021; CO 2022). This district recognizes existing industrial development within the county and the desirability of reserving additional land for possible new, expanded or relocated industries. It is intended that land zoned for industry be located so that conflict with incompatible uses would be minimized (DC 2018). The remainder of the CPS site is zoned primarily as a Rural Development District–2 (RD-2) with a small area zoned as a Rural Development District–1 (RD-1) (ALP 2021; CO 2022). RD-2 promotes the logical growth of uses around the County's communities for the increasing demand for rural non-farm development sites. RD-1 allows various uses along designated highways and is located on lots with at least a 240-foot frontage and that access of driveways is controlled. (ALP 2021; CO 2022)

3.2.2 Offsite Land Use

As described in Section 3.11 and listed in Table 3.11-2, McLean County has seen an increase in total population between 2010 and 2020, while DeWitt and Macon Counties have seen a decrease in total population for the same period.

As described in Section 3.1, the vicinity (6-mile radius) surrounding CPS is a mixture of towns, residential development, and agricultural lands with forested and natural areas interspersed. The land use/land cover categories located within the vicinity of CPS are illustrated in Figure 3.2-2. Cultivated crops are the largest land use/land cover category at approximately 73.4 percent. The next largest land use/land cover categories are deciduous forest and open water which represent 7.3 and 6.3 percent respectively, followed by developed areas (low/medium/high intensity) at 5.6 percent. The remaining eight land use/land cover categories account for approximately 7.4 percent of the vicinity. (MRLC 2019)

DeWitt County occupies approximately 254,431 acres of land, of which 185,936 acres (approximately 73.1 percent) are proportioned to farmland. The 2017 Census of Agriculture reports that the county had a total of 504 farms, with an average farm size of 369 acres. Approximately 444 farms produce crops, with the primary crops reported as soybeans (85,510 acres), corn for grain (85,067 acres), forage (1,450 acres), corn for silage or greenchop (96 acres), oats for grain (43 acres), orchards (25 acres), and potatoes (10 acres). Livestock is also an important product in the county, with livestock commodities such as layers (48 farms), cattle and calves (73 farms), sheep and lambs (23 farms), hogs and pigs (11 farms), and broilers and other meat-type chickens (1 farm). Other agricultural uses of farmland within the county include pastureland (150 farms; 3,826 acres), woodlands (117 farms; 3,606 acres), permanent pasture and rangeland (130 farms; 2,583 acres). (USDA 2017)

McLean County occupies approximately 757,274 acres of land, of which 620,056 acres (approximately 81.9 percent) are proportioned to farmland. The 2017 Census of Agriculture reports that the county had a total of 1,416 farms, with an average farm size of 438 acres. Approximately 1,331 farms produce crops, with the primary crops reported as soybeans (290,771 acres), corn for grain (281,899 acres), forage (3,801 acres), corn for silage or greenchop (2,061 acres), wheat for grain (1,866 acres), oats for grain (186 acres), potatoes (92 acres) and orchards (37 acres). Livestock is also an important product in the county, with livestock commodities such as cattle and calves (179 farms), layers (71 farms), hogs and pigs (37 farms), sheep and lambs (20 farms), and broilers and other meat-type chickens (3 farms). Other agricultural uses of farmland within the county include pastureland (280 farms; 5,890 acres), woodlands (225 farms; 5,963 acres), and permanent pasture and rangeland (242 farms; 4,320 acres). (USDA 2017)

Macon County occupies approximately 371,640 acres of land, of which 277,429 acres (approximately 74.6 percent) are proportioned to farmland. The 2017 Census of Agriculture reports that the county had a total of 589 farms, with an average farm size of 471 acres. Approximately 567 farms produce crops, with the primary crops reported as soybeans (129,258 acres), corn for grain (129,044 acres), forage (2,252 acres), corn for silage or greenchop (152 acres), oats for grain (106 acres), potatoes (36 acres), and orchards (26 acres). Livestock is also an important product in the county, with livestock commodities such as cattle and calves (67 farms), layers (12 farms), sheep and lambs (8 farms), hogs and pigs (4 farms), and broilers and other meat-type chickens (1 farm). Other agricultural uses of farmland within the county include woodlands (106 farms; 5,288 acres), pastureland (106 farms; 2,132 acres), and permanent pasture and rangeland (81 farms; 1,431 acres). (USDA 2017)

The Illinois Local Planning Technical Assistance Act (20 ILCS 662) provides technical assistance to Illinois local governments for the development of local planning ordinances and regulations, and encourages local governments to engage in planning, regulatory, and development approaches that promote and encourage comprehensive planning. Under this Act, The Department of Commerce and Economic Opportunity may make grants to local governments to develop, update, administer, and implement comprehensive plans. 20 ILCS 662 defines a comprehensive plan as a regional plan adopted under Section 5-14001 of the Counties Code, and official comprehensive plan adopted under Section 11-12-6 of the Illinois Municipal Code, or a local land resource management plan adopted under Section 4 of the Local Land Resource Management Planning Act. Any comprehensive plan funded under Section 15 of 20 ILCS 662 must address, but is not limited to addressing, each of the following elements: issues and opportunities, land use and natural resources, transportation, community facilities, telecommunications infrastructure, housing, economic development, natural resources, and public participation. (IGA 2002) Comprehensive plans are in place for DeWitt, McLean, and Macon Counties, and reflect the planning efforts of local and county governments, as well as public involvement in the planning process.

The updated DeWitt County Comprehensive Plan was approved November 26, 2018. The vision and goals of this 20-year plan build on and add to those of the existing comprehensive plan, originally adopted in 1992. The 1992 plan was guided by three underlying themes: to preserve the agriculture land resources in the county, promote DeWitt County's quality-of-life, and to encourage opportunistic development in the county. The updated comprehensive plan builds on the themes, goals, and objectives of the 1992 comprehensive plan, taking into consideration the changing development patterns and conditions in the county. The purpose of the plan is to provide a tool that would assist the county with progressing towards this vision. Implementation of the plan is intended to protect the county's rural character and important assets, while also encouraging economic growth. (DC 2018)

DeWitt County is within the State of Illinois Economic Development Region 3 (EDR 3) where major industrial employment is expected to grow or remain within the manufacturing, finance, business management, transportation, distribution & logistics, and healthcare industries. Employment is expected to increase in information technology, transportation, distribution and logistics, healthcare, and the manufacturing industries by 2022 given growth figures since 2012. It is recommended that the county review the plan at least every 5 years and update as needed (at least every 10 years). Like the Comprehensive Plan, it is recommended that development regulations (zoning and subdivision) ordinance be reviewed by the Regional Planning Commission every 5 years, or as needed, to address new land uses, building types, and modern design standards. (DC 2018)

McLean County Regional Comprehensive Plan was adopted in November 2009 and is designed to cover a period of approximately 25 years to the year 2035. An update cycle of 3-to-5 years or more is common, depending on local conditions and needs. This pattern has generally been followed in McLean County and should be continued for the foreseeable future. Over 88 percent of McLean County is currently unincorporated, agricultural land, and nearly 6 percent is urban development. Bloomington and Normal, Illinois, by far account for the greatest portion of the urban land with the remainder accounted for by the county's 19 other municipalities. (MCP 2009)

A major portion of McLean County's growth has been in the Bloomington-Normal urban area. The likelihood of continued expansion of the urban area is supported by trends toward smaller households and low-density development, both of which contribute to greater per capita consumption of land for urban development. Development outside planned urban growth areas is expected to be limited due to county zoning requirements and the use of annexation agreements by Bloomington and Normal. Although the region's growth will continue to present a challenge for preserving farmland and open space, the achievement of more compact development by its very nature would reduce land consumption of all types. (MCP 2009)

The Macon County & Decatur Comprehensive Plan was adopted in 2009 and serves as the principal planning document addressing Macon County and Decatur's goals and policies related to land use and key community issues. The plan's vision includes focusing new development adjacent to the developed areas and preserving high quality environments which promote resource conservation and biodiversity. Development patterns have increasingly become suburban, characterized by tracts of single-family housing along major arterial roads. Macon county is in the midst of a fundamental transition from an industrial economy as the county's regional role as a provider of retail and healthcare services continues to grow. It is, however, the image and identity of a leading agricultural industry that positions the county to become the center of technological innovation and research in agri-business, healthcare, and other regionally significant industries. The plan commits a prioritization of the land use, transportation and infrastructure changes that are necessary to ensure that this transition is successful. As a major center for agribusiness, vast expanses of corn and soybean cropland cover 84 percent of the county. Over 100,000 residents and many local, yet global, businesses participate in a thriving agricultural economy focused within the central city of Decatur. Residents of Macon County value and wish to preserve its woodlands, wetlands, and watersheds. (CDI 2009)

3.2.3 Visual Resources

As discussed in Section 3.1, CPS is located on the irregular U-shaped bend of Clinton Lake and within several townships of DeWitt County, Illinois. Figure 3.1-1 shows the CPS site layout and site boundary in association with Clinton Lake. The surrounding area is a mixture of agricultural land, deciduous forest, rural residential, towns and small communities.

Predominant visual features at CPS include the containment dome, associated turbine building, and the meteorological and microwave (backup meteorological) towers. The containment building dome is the most visible feature at the site with a height of approximately 196 feet. While visual screening by the area terrain and wooded areas is present and generally prevents visibility of the station to the public, the station is visible from several vantage points, including: from portions of Clinton Lake directly west of the station; along portions of Route 54 when heading west from Farmer City, Illinois; from Route 10 when heading west from Deland, Illinois; along portions of Route 54 when heading east from Clinton, Illinois; and along portions of Birkbeck Road when heading south towards the station. There are no plans for refurbishment that would create new visual impacts during the proposed LR operating term. Therefore, CPS would continue to have minimal visual impact on neighboring residential areas and communities.

Table 3.2-1 Land Use/Land Cover, CPS Site

Category	Acres	Percentage
Open Water	4,922.0	36.1
Developed, Open Space	223.3	1.6
Developed, Low Intensity	299.3	2.2
Developed, Medium Intensity	120.1	0.9
Developed, High Intensity	98.1	0.7
Barren Land (Rock/Sand/Clay)	7.1	0.1
Deciduous Forest	3,061.3	22.5
Evergreen Forest	85.2	0.6
Mixed Forest	1,470.9	10.8
Shrub/Scrub	31.6	0.2
Grassland/Herbaceous	397.0	2.9
Hay/Pasture	1,047.3	7.7
Cultivated Crops	1,671.5	12.3
Woody Wetlands	160.8	1.2
Emergent Herbaceous Wetlands	30.0	0.2
Total	13,625.5	100

The acreages presented in this table are based on the Multi-Resolution Land Characteristics Consortium (MRLC) land use/land cover data. These data are presented in a raster (pixel-based) format and because of their square geography, they do not exactly match the CPS site boundary. This geographic variation creates a small difference between total acreages reported in Table 3.2-1 compared to the CPS site acreage reported throughout the ER. (MRLC 2019)

Table 3.2-2 Land Use/Land Cover, 6-Mile Radius of CPS

Category	Acres	Percentage
Open Water	4,566.2	6.3
Developed, Open Space	1,566.8	2.2
Developed, Low Intensity	1,908.8	2.6
Developed, Medium Intensity	424.8	0.6
Developed, High Intensity	161.7	0.2
Barren Land (Rock/Sand/Clay)	24.7	0.03
Deciduous Forest	5,291.9	7.3
Evergreen Forest	47.8	0.1
Mixed Forest	1,779.8	2.5
Shrub/Scrub	40.3	0.1
Grassland/Herbaceous	438.1	0.6
Hay/Pasture	2,781.0	3.8
Cultivated Crops	53,157.9	73.4
Woody Wetlands	176.1	0.2
Emergent Herbaceous Wetlands	29.6	0.04
Total	72,395.5	100

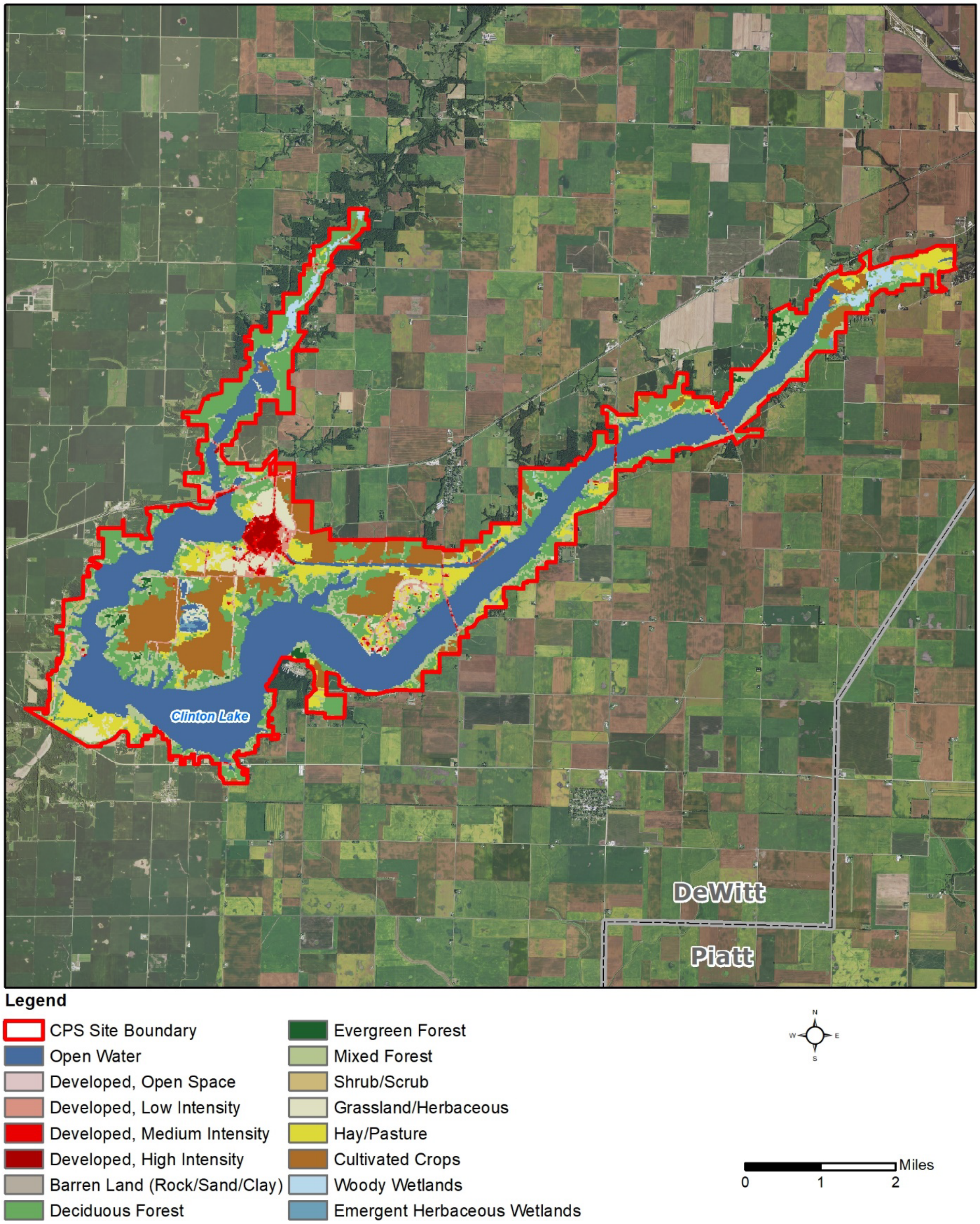


Figure 3.2-1 Land Use/Land Cover, CPS Site

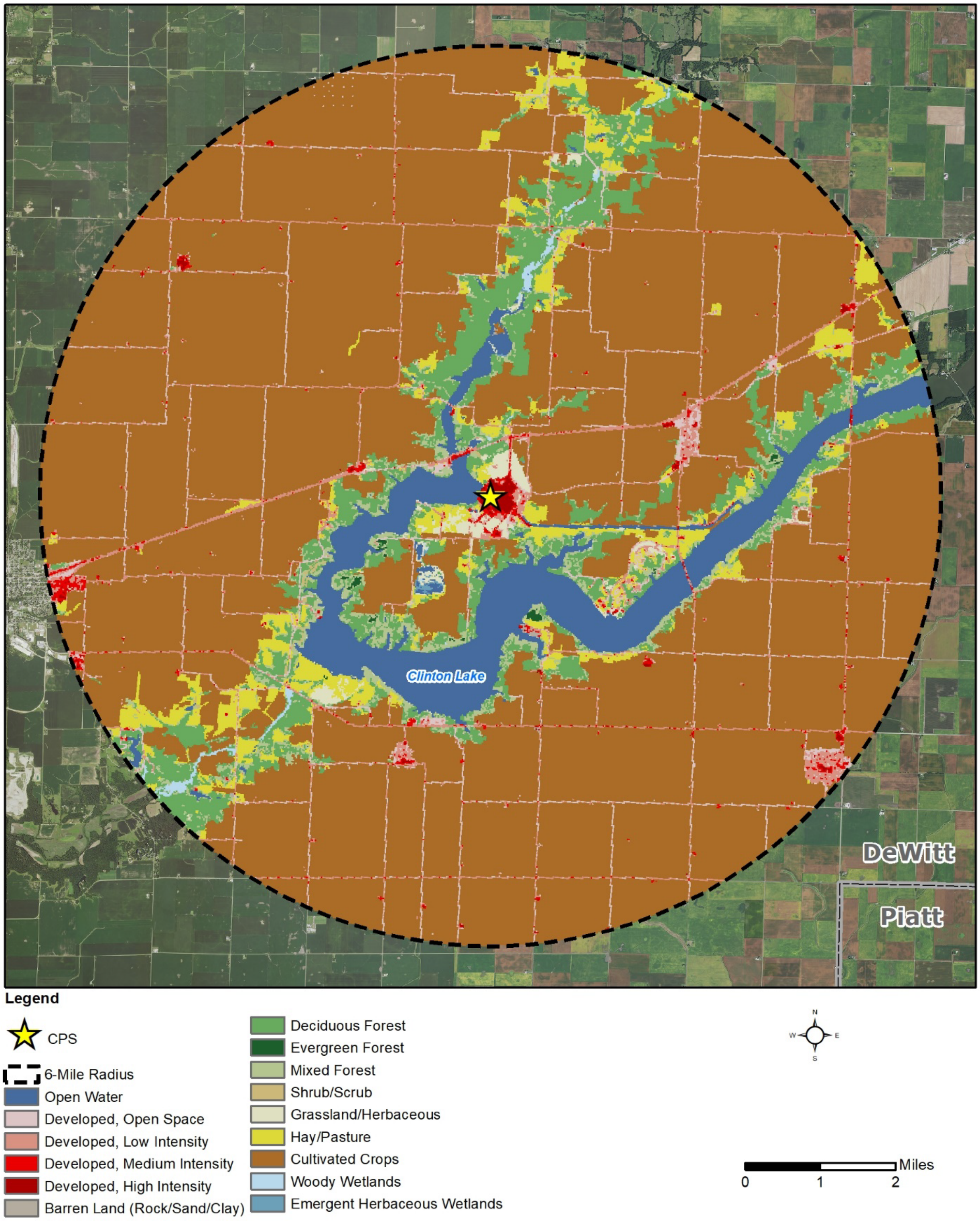


Figure 3.2-2 Land Use/Land Cover, 6-Mile Radius of CPS

3.3 Meteorology and Air Quality

CPS is located approximately 7 miles east of the city of Clinton in east-central Illinois. A high-level overview of the station layout is provided in Figure 3.1-1.

Climatological data presented below have been provided to represent a range of meteorological conditions considered typical for the CPS site region. The Peoria, Illinois (KPIA) and Springfield, Illinois (KSPI) stations are the closest first-order National Weather Service (NWS) data collection stations to CPS with a significant period of meteorological data, and thus have been used to describe the representative climatic conditions. Peoria and Springfield climatological information has been used in previous CPS USAR environmental reviews, thus making its continued use appropriate for comparison. (EGC 2020a)

3.3.1 General Climate

The Peoria station (KPIA) is situated approximately 55 miles northwest of the CPS site (EGC 2020a). The area is characterized by relatively flat tableland surrounded by well-drained and gently rolling terrain. The local climate is predominantly continental with changeable weather and wide ranges of temperature extremes. June and September are usually the most pleasant time of the year. An extended period of warm, dry weather occurs during October or the first of November. Based on the 1951-1980 period, the average first occurrence of 32°F temperature in the fall is October 20, and the average last occurrence in the spring is April 24. Precipitation is normally heaviest during the growing season and lowest during midwinter. The earliest snowfalls have occurred in September, with heavy snowfalls rarely exceeding 20 inches. (NCDC 2022a)

The Springfield station (KSPI) is approximately 49 miles west-southwest of the CPS site (EGC 2020a). The land surrounding the station is nearly level with rolling terrain found near the Sangamon River and Spring Creek. The station is located near the center of North America and therefore experiences a typical continental climate with warm summers and fairly cold winters. Conditions are generally pleasant with sharp seasonal changes, but no extended periods of severely cold weather. Monthly temperatures range from the upper 20s for January to the upper 70s for July. Considerable variation may take place within the seasons, as temperatures of 70°F or higher may occur in the winter while temperatures near 50°F are sometimes recorded during the summer months. Based on the 1951-1980 period, the average first occurrence of 32°F in the fall is October 19 and the average last occurrence in the spring is April 27. Summer weather is often uncomfortably warm and humid with abundant sunshine and few cloudy days. Monthly precipitation ranges from about 2 inches in January to a little over 4 inches in May and June. Thunderstorms are common during warmer months, with nearly two-thirds of all storms occurring during the months of May through August. These storms are sometimes locally severe with brief but heavy rainfall and occasionally are accompanied by damaging hail. The prevailing wind direction for the area is southerly during most of the year with northwesterly winds during the late fall and early springs months. March is the windiest month, with August experiencing the calmest wind conditions. Wind velocities of more than 40 miles per hour (mph) are not unusual for brief periods in most months of the year. (NCDC 2022a)

The CPS site is located near the geographical center of Illinois. The terrain is generally flat with low rolling hills and river valleys. The climate for the region of CPS is typically continental, with cold winters, warm summers, and frequent short-period fluctuations in temperature, humidity, cloudiness, and wind direction. (EGC 2020a) Detailed meteorological information for CPS is described in Section 3.3.2.

3.3.2 Meteorology

As discussed in Section 3.3, the climatological conditions for the CPS region and site have been evaluated by the NRC as part of the USAR. For the proposed LR of CPS, CEG completed a review of the most recent meteorological information available from public sources and from CPS monitoring to confirm the conclusions of the previous review remains valid. The hourly meteorological data for CPS was collected from January 2005 through December 2021. Due to historical technical data system limitations, hourly meteorological data for CPS prior to January 1, 2005, are not available. A summary of CEG's evaluation is provided below.

3.3.2.1 Wind Direction and Speed

As illustrated in Figure 3.3-1, the prevailing wind direction (i.e., the direction from which the wind blows most often) at the CPS Site is from the south-southwest. In fall, spring, and summer, the prevailing wind direction is from the south-southwest, and during the winter it is from the west-northwest (see Figures 3.3-1 through 3.3-5). The average annual wind speed for the past 5 years (2017-2021) is 8.0 mph which is lower than the 38-year average of 8.3 mph at Peoria (KPIA) and the 38-year average of 9.3 mph at Springfield (KSPI). (NCDC 2022a)

For Peoria (KPIA), the 53-year period of record data shows the annual prevailing wind direction is from 190 degrees (i.e., from the south). Monthly prevailing winds are from the south during the spring, summer, and fall. In the winter, the mean prevailing wind direction is from the west. As listed in Table 3.3-1, the mean wind speed over the past 38-year period of record was 8.3 mph. A maximum 3-second wind speed of 70 mph was recorded in November of 2015 at KPIA. (NCDC 2022a)

For Springfield (KSPI), the 47-year period of record data shows the annual prevailing wind direction is from 180 degrees (i.e., from the south). Monthly prevailing winds are from the south during the spring and fall. During the summer, the wind direction is from the south and southwest. In the winter, the mean prevailing wind direction is from the west. As listed in Table 3.3-1, the mean wind speed over the past 38-year period of record was 9.3 mph. The maximum 3-second wind speed of 75 mph was recorded in December of 2018 at KSPI. (NCDC 2022a)

Mean monthly wind speeds at the CPS site are provided in Table 3.3-2, based on a 17-year record of measurement from the onsite meteorological monitoring system, lower level (32.8 feet above ground level). The average wind speed on an annual basis was 8.4 mph, indicating the site wind speeds are lower than Springfield (KSPI) but higher than Peoria (KPIA). The onsite monitoring data indicate the wind at CPS is from west-northwest during the coldest months (December through February), and varies between the northeast, south, and south-southwest from March through November. Seasonal wind rose diagrams for the period of 2017−2021 are provided in Figure 3.3-1, Figure 3.3-2, Figure 3.3-3, Figure 3.3-4, and Figure 3.3-5.

3.3.2.2 Temperature

Representative regional temperature averages and extremes are available from Peoria (KPIA) and Springfield (KSPI). The local climate data summary for the Peoria (KPIA) area indicates that the mean daily maximum temperature is highest during July (86.6°F) and decreases to a seasonal low in January (32.4°F). The Peoria area experiences normal temperatures above 90°F approximately 23.1 days per year in May through October. The highest temperature of record (105°F) occurred in June 1988. The mean daily minimum temperature is above 50°F in May, June, July, August, and September and is at its lowest in January, when the mean daily minimum decreases to 16.6°F. Record low temperatures less than 0°F have been recorded in November, December, January, February, and March with below freezing temperatures normally occurring approximately 117.6 days per year in every month except June, July, and August. The lowest temperature of record at the Peoria (KPIA) station is -25°F, occurring in January 1977. (NCDC 2022a) Monthly and annual daily mean temperature data and temperature extremes for Peoria (KPIA) are summarized in Table 3.3-3.

The local climate data summary for the Springfield (KSPI) area indicates that the mean daily maximum temperature is highest during July (87.5°F) and decreases to a seasonal low in January (34.9°F). The Springfield area experiences normal temperatures above 90°F approximately 28.2 days per year in May through October. The highest temperature of record (112°F) occurred in July 1954. The mean daily minimum temperature is above 50°F in May, June, July, August, and September and is at its lowest in January, when the mean daily minimum decreases to 19.1°F. Record low temperatures less than 0°F have been recorded in November, December, January, February, and March with below freezing temperatures normally occurring approximately 110.9 days per year in every month except June, July, and August. The lowest temperature of record at the Springfield (KSPI) station is -22°F, occurring in February 1963. (NCDC 2022a) Monthly and annual daily mean temperature data and temperature extremes for Springfield (KSPI) are summarized in Table 3.3-3.

Average temperatures in the area of CPS range from 27.1°F in January to 75.2°F in July, with annual extremes of -18.1°F (low) and 98.8°F (high). Monthly and annual mean daily temperature data and temperature extremes for the CPS area are summarized in Table 3.3-4. The 5-year average for CPS (53.5°F) is slightly higher than the 17-year annual average of 53.0°F. Both values fall between the annual mean daily minimum (41.8°F) and the annual daily maximum (61.1°F) for Peoria (KPIA) and the annual mean daily minimum (43.6°F) and annual mean daily maximum (63.0°F) for Springfield (KSPI). (NCDC 2022a)

3.3.2.3 Precipitation

The precipitation records of normal rainfall totals for the Peoria (KPIA) area indicate that precipitation of 0.01 inches or more occurs on average 117.2 days per year, with 8.4 or more days per month receiving at least some precipitation. As listed in Table 3.3-5, the annual average precipitation at the Peoria (KPIA) station is 37.55 inches per year. Precipitation recorded at the station ranges from 1.99 inches in February to 4.69 inches in May. Seasonally, the winter months have the lowest amount of annual precipitation, accounting for approximately 16.7 percent while spring months have the highest at approximately 30.3 percent. The summer and fall seasons have similar amounts of precipitation (28.1 and 24.9 percent respectively). The maximum 24-hour precipitation total recorded at Peoria (KPIA), 5.19 inches, occurred in July 2020. Peoria (KPIA) received a record minimum monthly rainfall total of 0.03 inches in September 1979. (NCDC 2022a)

The precipitation records of normal rainfall totals for the Springfield (KSPI) area indicate that precipitation of 0.01 inches or more occurs on average 114.7 days per year, with 8.2 or more days per month receiving at least some precipitation. As listed in Table 3.3-5, the annual average precipitation at the Springfield (KSPI) station is 38.04 inches per year. Precipitation recorded at the station ranges from 1.93 inches in February to 4.61 inches in June. Seasonally the winter months have the lowest amount of annual precipitation, accounting for approximately 16.1 percent while summer months have the highest at approximately 31.1 percent. The spring and fall seasons have similar amounts of annual precipitation at 29.6 and 23.3 percent respectively. The maximum 24-hour precipitation total recorded at Springfield (KSPI), 6.12 inches, occurred in December 1982. Springfield (KSPI) received a record minimum monthly rainfall total of 0.04 inches in January 1986. (NCDC 2022a)

Representative precipitation data for the area of CPS is available from the Clinton 1 SSW, Illinois, weather station located approximately 7-miles west-southwest of CPS in Clinton, Illinois. The average annual precipitation at Clinton 1 SSW is 40.4 inches, which is more than both Peoria (KPIA) and Springfield (KSPI). Precipitation recorded at the station is cyclic with the lowest amount occurring during the winter months then peaking in summer. The precipitation pattern is similar to Peoria (KPIA) and Springfield (KSPI) with a gradual decrease during the fall and winter months before increasing during the spring and summer months. For Clinton 1 SSW, the maximum monthly precipitation of 13.9 inches occurred in July 1992. (NCDC 2022b) Monthly annual precipitation data extremes for the Clinton 1 SSW and CPS area are summarized in Table 3.3-6.

3.3.2.4 Snow and Glaze

Snowfall at the site is not recorded by CPS. However, representative snowfall data are available for Peoria (KPIA) and Springfield (KSPI).

The Peoria (KPIA) area normally receives 26.2 inches of snow per year, with approximately 8.1 days per year receiving at least 1 inch or more of snowfall. The largest snowfall in a 24-hour period, 12.2 inches, occurred in January 1979. Since 1992, annual snowfall has ranged from as little as 7.8 inches to 57.6 inches. (NCDC 2022a)

The Springfield (KSPI) area normally receives 21.8 inches of snow per year, with approximately 6.2 days per year receiving at least 1 inch or more of snowfall. The largest snowfall recorded at KSPI in a 24-hour period, 17.0 inches, occurred in March 2013. Since 1992, annual snowfall has ranged from as little as 8.5 inches to 45.7 inches. For both KPIA and KSPI, the lowest and highest annual snowfalls occurred the winters of 1993-1994 (lowest) and 2013-2014 (highest). (NCDC 2022a)

3.3.2.5 Relative Humidity and Fog

The local climatological data for Peoria (KPIA) and Springfield (KSPI) indicate an average of 21.2 days per year and 18.4 days per year of heavy fog, respectively. Heavy fog is defined by the NWS as fog which reduces visibility to 0.25 miles or less. (NCDC 2022a) Fog at the site is not recorded by CPS.

3.3.2.6 Severe Weather

3.3.2.6.1 Thunderstorms

For the Peoria (KPIA) and Springfield areas, thunderstorms are most frequent during the summer months, with the greatest occurrence during the month of June. The mean number of days with thunderstorms in each month for Peoria (KPIA) and Springfield (KSPI) are provided in Table 3.3-7. (NCDC 2022a)

A severe thunderstorm is defined the by the NWS Storm Prediction Center as a thunderstorm that produces one or more of the following:

a. wind gusts of 58 mph or greater,

b. hail 1 inch in diameter or larger, and/or

c. a tornado. (NWS 2022)

Based on National Centers for Environmental Information (NCEI) records, DeWitt County, Illinois has recorded 186 severe thunderstorm (including hailstorm) events since 1950, with most occurring in May and June (NCEI 2022).

3.3.2.6.2 Tornados

Based on the NCEI records, a total of 22 tornados have been recorded in DeWitt County, Illinois since 1950. The records show that the intensity of the storms was limited to F0, EF0, F1, F2 with one F4 that occurred May 5, 1977. (NCEI 2022)

3.3.2.6.3 Hurricanes

The NCEI does not have any record of a hurricane in DeWitt County, Illinois (NCEI 2022). Based on the National Oceanic and Atmospheric Administration's (NOAA's) Historic Hurricane Track-GIS map viewer, there are no records of any hurricane in the State of Illinois (NOAA 2022a).

3.3.2.7 Atmospheric Stability

Atmospheric stability is a meteorological parameter that describes the dispersion characteristics of the atmosphere. It can be determined by the difference in temperature between two heights. A seven-category atmospheric stability classification scheme (ranging from A for extremely unstable to G for extremely stable) based on temperature differences is set forth in the NRC's Regulatory Guide 1.23, Revision 1 (NRC 2007). When the temperature decreases rapidly with height (typically during the day when the sun is heating the ground), the atmosphere is unstable and atmospheric dispersion is greater. Conversely, when temperature increases with height (typically during the night as a result of the radiative cooling of the ground), the atmosphere is stable, and dispersion is more limited. The stability category between unstable and stable conditions is D (neutral), which would occur typically with higher wind speeds and/or higher cloud cover, irrespective of day or night. (NRC 2013b)

Based on a 5-year average (2018−2022), onsite temperature difference data recorded at CPS indicate that stable atmospheric conditions (E to G) occurred about 45.2 percent of the time and unstable conditions (A to C) occurred about 13.2 percent of the time. The remaining observations (about 41.6 percent) fell into the neutral (D) category. Stability class distributions at CPS covering the period 2018−2022 are presented in Table 3.3-8.

3.3.3 Air Quality

3.3.3.1 Clean Air Act Nonattainment Maintenance Areas

The Clean Air Act (CAA) was established in 1970 [42 USC § 7401 et seq.] to reduce air pollution nationwide. The EPA has developed primary and secondary national ambient air quality standards (NAAQS) under the provisions of the CAA. The EPA classifies air quality within an air quality control region (AQCR) according to whether the region meets or exceeds federal primary and secondary NAAQS. An AQCR or a portion of an AQCR may be classified as being in attainment or non-attainment, or it may be unclassified for each of the six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$, fine particulates; and PM_{10}, coarse particulates), ozone, and sulfur dioxide (SO_2).

Emissions from non-radiological air pollution sources, including the criteria pollutants, are controlled through compliance with federal, state, and local regulations. Nonattainment areas are areas where the ambient levels of criteria air pollutants in the air violate the criteria set forth in federal, state, and local regulations. Attainment areas are areas that meet the criteria or cannot be classified (depending on the pollutant and other factors). A maintenance area is an area that formerly violated the attainment criteria but currently meets the attainment criteria. (EPA 2023)

There are no Class I Federal areas, in which visibility is an important value, as designated in 40 CFR, Part 81, Subpart D, within 100 miles of CPS.

Four AQCRs fall within the CPS region. These AQCRs include the Burlington-Keokuk Interstate AQCR (40 CFR 81.98), the North Central Illinois Intrastate AQCR (40 CFR 81.262), the East Central Illinois Intrastate AQCR (40 CFR 81.263) and the West Central Illinois Intrastate AQCR (40 CFR 81.264). CPS falls within the East Central Illinois Intrastate AQCR, which consists of 15 counties in Illinois. As of June 30, 2023, all of the counties in the 62-mile area are in attainment. Three of the counties are maintenance areas. LaSalle County, in the North Central Illinois Intrastate AQCR, is a maintenance area for PM_{10} (1987). Peoria and Tazewell Counties, in the Burlington-Keokuk Interstate AQCR, are maintenance areas for SO_2 (1971) and SO_2 (2010). These maintenance areas are illustrated in Figure 3.3-6. (EPA 2023)

3.3.3.2 Air Emissions

The IEPA issues the Federally Enforceable State Operating Permit (FESOP), New Source Performance Standards (NSPS), and National Emissions Standard for Hazardous Air Pollutants (NESHAP) for air emissions as required by the State of Illinois on behalf of the EPA under a delegation agreement. Permitted air emissions sources are summarized in Table 3.3-9.

CPS holds a FESOP to operate three large diesel-powered generating units, one 755 hp diesel-powered generator, four smaller diesel-powered generators, three diesel-powered fire pumps, three storage tanks, two oil separator units and three parts washers in accordance with the provisions of Air Emission Permit No. 039804AAC. Summaries of the emission units are listed in Table 3.3-9. CPS operational cooling modes of condenser cooling include the use of cooling towers for part of the year. Section 2.2.3.1 details the circulating water system. The CPS cooling towers are exempted from state permit requirements. (IAC 2022)

The permitted emission sources at CPS are regulated by the applicable regulations cited in the permit. In addition, the emissions reports submitted to the IEPA each year contain tabular summary information related to the permitted emissions units listed in Attachment A of the air permit. Criteria pollutants and applicable hazardous air pollutants (HAPs) are summed and reported for each station in the annual update and emission statement submitted to the IEPA. Annual emissions for the years 2018−2022 are listed in Table 3.3-10.

As presented in Chapter 9, there have been no notices of violation (NOVs), or non-compliances associated with CPS air emissions over the 5 years from 2018 through 2022.

As presented in Section 2.3, no LR-related refurbishment activities have been identified. In addition, CEG's review did not identify any future upgrade or replacement activities necessary for station operations (e.g., diesel generators, diesel pumps) that would affect CPS's current air emissions program. Therefore, no increase or decrease of air emissions is expected over the proposed LR operating term.

Studies have shown that the amount of ozone generated by even the largest industry transmission lines in operation (765-kV) would be insignificant (NRC 2013a). As presented in Section 2.2.5.1, the in-scope transmission lines at CPS are 138-kV and 345-kV. Therefore, the amount of ozone generated from in-scope transmission lines is anticipated to be minimal.

There are no known field tests concerning ozone and nitrogen oxides emissions generated by CPS's 138-kV and 345-kV in-scope transmission lines. Studies have shown that the amount of ozone generated by even the largest industry transmission lines in operation (765-kV) would be insignificant (NRC 2013a). As presented in Section 2.2.5, the in-scope transmission lines at CPS are 138-kV and 345-kV. Therefore, the amount of ozone generated from in-scope transmission lines is anticipated to be minimal.

3.3.4 Greenhouse Gas Emissions

CEG records carbon dioxide equivalent (CO_2e) emissions for the CPS station that include direct emissions and indirect emissions. The direct emissions include emissions from stationary combustion sources, process carbon dioxide (CO_2), fugitive sulfur hexafluoride (SF_6), HFC/PFC refrigerants, and ODC refrigerants. Indirect emissions include onsite electricity usage. No CPS data exist for mobile emission sources such as the commuting workforce, visitors, and delivery vehicles. Therefore, CEG calculated greenhouse gas (GHG) emissions on station activities where information was readily available. GHG emissions generated at CPS are presented in Table 3.3-11.

As listed in Table 3.3-11, the direct emission values peaked in 2020. The increased direct emissions during 2019 and 2020 were from fugitive R-134a emissions due to a problem with the plant's chilled water system. The problem was resolved and recorded in CPS's corrective action program.

Table 3.3-1 Regional Wind Conditions, Peoria (KPIA) and Springfield (KSPI), Illinois

	Period of Record	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Peoria, Illinois (KPIA)														
Mean Speed (mph)	38 years	9.4	9.2	10.0	9.9	8.4	7.4	6.4	5.9	6.6	7.9	9.1	8.9	8.3
Prevailing Direction (degrees from)	53 years	300	310	190	190	190	190	190	190	190	190	190	190	190
Max 3-Second Speed (mph)	27 years	54	55	64	56	64	61	51	64	60	60	70	54	70
Max Speed Year of Occurrence		2014	2012	1998	1997	2003	2011	2016	2016	2007	1996	2015	2021	Nov. 2015
Springfield, Illinois (KSPI)														
Mean Speed (mph)	38 years	10.9	10.7	11.3	11.3	9.5	7.8	6.7	6.3	7.1	8.9	10.6	10.4	9.3
Prevailing Direction (degrees from)	47 years	310	310	180	190	190	190	200	190	190	190	180	190	180
Max 3-Second Speed (mph)	26 years	55	64	60	74	68	70	62	60	47	55	63	75	75
Max Speed Year of Occurrence		2017	2014	2019	2002	2008	2021	2001	2009	2019	2018	2019	2018	Dec. 2018

(NCDC 2022a)

Table 3.3-2 CPS Wind Conditions

	Period of Record (years)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Speed (mph)	17	10.3	9.9	9.7	9.8	8.0	7.1	6.1	5.9	6.5	8.3	9.5	9.4	8.4
Prevailing Direction (degrees from)	17	290	290	50	190	190	200	210	40	40	200	190	290	190

Table 3.3-3 Regional Temperatures, Peoria (KPIA) and Springfield (KSPI), Illinois

	Period of Record	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Peoria, Illinois (KPIA)														
Mean Daily Maximum (°F)	129	32.4	35.8	48.8	61.6	73.1	82.2	86.6	84.5	77.3	65.3	49.3	36.5	61.1
Highest Daily Maximum (°F)	83	70	74	86	92	97	105	104	103	100	93	81	71	105
Year of Occurrence		1989	2017	1986	1986	2018	1988	2012	1988	2011	2006	1950	1982	June 1988
Mean Daily Minimum (°F)	129	16.6	19.4	30.3	40.9	51.5	60.9	65.3	63.3	55.4	43.9	31.9	21.6	41.8
Lowest Daily Minimum (°F)	83	-25	-19	-10	14	25	39	47	41	26	19	-2	-23	-25
Year of Occurrence		1977	1996	1960	2018	1966	1993	1972	1986	1942	1972	1977	1989	Jan. 1977
Springfield, Illinois (KSPI)														
Mean Daily Average (°F)	121	34.9	38.8	50.9	63.7	74.5	83.6	87.5	85.3	79.0	67.0	51.5	38.8	63.0
Highest Daily Maximum (°F)	74	71	76	87	90	98	103	112	103	102	93	83	74	112
Year of Occurrence		1950	2017	1981	1986	2018	1954	1954	1964	2011	2006	1950	2012	July 1954
Mean Daily Minimum (°F)	121	19.1	22.3	32.2	42.8	53.3	62.6	66.7	64.7	56.6	45.5	33.9	23.8	43.6
Lowest Daily Minimum (°F)	74	-21	-22	-12	16	28	39	48	43	32	17	-3	-21	-22
Year of Occurrence		1999	1963	1960	2018	1966	2003	2013	1986	2003	1952	1964	1989	Feb. 1963

(NCDC 2022a)

Table 3.3-4 CPS Site Temperatures

	Period of Record (years)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Monthly Average (°F) [(a)]	17	27.1	29	42	53.3	63.9	73.3	75.2	73.7	67.9	55.5	42.7	32.5	53.0
Highest Daily Maximum (°F)	17	64.8	70	81.1	85.8	92.5	98.1	99.8	94.1	98.1	88.8	78.2	69.2	99.8
Year of Occurrence		2008	2017	2012	2007	2018	2012	2012	2007/2012	2011	2019	2016	2012	July 2012
Lowest Daily Minimum (°F)	17	-18.1	-9.1	-2.8	15.5	33.6	47.8	52.7	48.8	40.4	27.4	6.7	-5.5	-18.1
Year of Occurrence		2019	2014	2019	2018	2020	2009	2013	2009	2007	2019	2019	2017	Jan 2019

a. Calculated average of all temperature measurements for each month and of all measurements for the period of January 2005-December 2021

Table 3.3-5 Regional Precipitation, Peoria (KPIA) and Springfield (KSPI), Illinois

	Period of Record	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Peoria, Illinois (KPIA)														
Normal Monthly Precipitation (inches)	30 years	2.06	1.99	2.69	3.99	4.69	3.73	3.53	3.31	3.48	3.17	2.7	2.21	37.55
Maximum Monthly Precipitation (inches)	83 years	8.11	5.37	7.49	8.66	10.41	11.69	10.15	8.61	13.09	10.8	7.62	6.34	13.09
Year of Occurrence		1965	1997	2009	1947	2013	1974	1993	1965	1961	1941	1985	1949	Sep. 1961
Maximum 24 hour (inches)	83 years	4.45	3.34	3.39	5.06	3.62	4.44	5.19	4.32	4.72	4.03	4.32	3.38	5.19
Year of Occurrence		1965	1997	1944	1950	1956	1974	2020	1955	2008	2021	1990	1949	July 2020
Minimum Monthly Precipitation (inches)	83 years	0.22	0.33	0.39	0.71	0.69	0.60	0.33	0.25	0.03	0.03	0.22	0.32	0.03
Year of Occurrence		1986	1947	1958	1971	2005	1988	1988	1992	1979	1964	1999	1995	Sep. 1979
Springfield, Illinois (KSPI)														
Normal Monthly Precipitation (inches)	30 years	2.03	1.93	2.76	3.97	4.52	4.61	3.85	3.37	2.88	3.26	2.71	2.15	38.04
Maximum Monthly Precipitation (inches)	74 years	5.67	4.89	7.89	9.91	10.90	9.22	10.76	10.82	8.57	11.32	6.94	8.94	11.32
Year of Occurrence		1949	1990	1973	1964	2013	1990	1981	2016	1986	2009	1985	1982	Oct. 2009
Maximum 24 hour (inches)	74 years	2.78	2.54	2.84	4.45	3.95	4.99	4.63	5.59	5.12	3.51	2.74	6.12	6.12
Year of Occurrence		1975	1990	1972	1979	1990	2008	2018	2016	1959	1973	2003	1982	Dec. 1982
Minimum Monthly Precipitation (inches)	74 years	0.04	0.45	0.63	0.73	0.52	0.23	0.34	0.25	T	0.16	0.25	0.15	0.04
Year of Occurrence		1986	2017	1956	1971	1992	1959	2012	2011	1979	1964	1999	1955	Jan. 1986

(NCDC 2022a)

Table 3.3-6 CPS Precipitation Records

	Period of Record (years)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Monthly Precipitation (inches)	30	2.38	1.96	2.85	3.89	4.65	4.62	4.37	3.42	3.00	3.68	3.12	2.49	40.4
Maximum Monthly Precipitation (inches)	30	6.57	6.00	5.12	8.92	10.76	9.96	13.91	8.09	9.75	10.48	7.54	7.98	13.91
Year of Occurrence		2005	2018	1998	1994	1995	2010	1992	2014	2008	2009	1992	2015	July 1992
Minimum Monthly Precipitation (inches)	30	0.68	0.00	0.10	1.26	0.50	0.63	1.17	0.22	0.23	1.11	0.42	0.47	0.00
Year of Occurrence		2009	2008	2013	1997	1992	2012	2012	2013	2004	2010	1999	2017	Feb. 2008

(NCDC 2022b)

Table 3.3-7 Regional Thunderstorms, Peoria (KPIA) and Springfield (KSPI), Illinois

Peoria, Illinois (KPIA)														
	Period of Record (years)	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANNUAL**
Mean Days with Thunderstorms	116	0.4	0.7	2.5	4.5	6.7	8.2	7.2	6.6	4.6	2.3	1.2	0.5	45.4
Springfield, Illinois (KSPI)														
	Period of Record (years)	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANNUAL**
Mean Days with Thunderstorms	121	0.5	0.8	2.8	4.8	7	8.4	7.7	6.7	4.2	2.3	1.4	0.5	47.1

(NCDC 2022a)

Table 3.3-8 CPS Stability Class Distribution

Percent Frequency of Occurrence by Stability Pasquill Stability Class[a]							
YEAR	**A**	**B**	**C**	**D**	**E**	**F**	**G**
2018	2.3	4.4	7.1	39.6	34.7	8.5	3.3
2019	2.1	3.7	6.4	43.5	32.6	8.1	3.7
2020	2.4	4.4	7	42.7	31.1	7.9	4.4
2021	1.2	2.7	5.3	42.8	35.6	8.8	3.7
2022	5.4	5.2	6.2	39.6	30.9	8	4.7
2018-2022	2.7	4.1	6.4	41.6	33	8.2	4

a. Classes are as follows (NRC 2007):
Class A: Extremely unstable
Class B: Moderately unstable
Class C: Slightly unstable
Class D: Neutral
Class E: Slightly stable
Class F: Moderately stable
Class G: Extremely stable

Table 3.3-9 CPS Permitted Air Emission Sources (Sheet 1 of 3)

Emission Source[a,b]	Description	Capacity Rating	Permit Conditions[c]
Unit 1A Unit 1B Unit 1C	Diesel-Powered Generating Units	2,305 hp + 3,070 hp or 5,375 (1A and 1B) 3,070 hp (1C)	May burn distillate fuel oil only containing no more than 0.28% by weight sulfur. Distillate fuel usage limited to 26,390 gallons/month and 211,125 gallons per year CO limited to 12.56 tons/year Nitrogen oxides limited to 47.29 tons/year Particulate matter limited to 1.48 tons/year Sulfur dioxide limited to 4.18 tons/year Volatile organic matter (VOM) limited to 1.21 tons/year Opacity shall not exceed 30% except for one eight-minute period per hour of not more than 60% opacity.
Cummins Onan DF-Series	Diesel-Powered Generating Set	755 hp	May burn distillate fuel oil only containing no more than 0.05% by weight sulfur. Distillate fuel usage limited to 2,175 gallons/ month and 17,400 gallons per year Carbon monoxide limited to 1.04 tons/year Nitrogen oxides limited to 1.87 Tons/Year Particulate matter limited to 0.01 tons/year Sulfur dioxide limited to 0.06 Tons/Year VOM limited to 0.10 tons/year Opacity shall not exceed 30% except for one eight-minute period per hour of not more than 60% opacity.

Table 3.3-9 CPS Permitted Air Emission Sources (Sheet 2 of 3)

Emission Source[1,2]	Description	Capacity Rating	Permit Conditions[3]
Diesel Fire Pump A	Diesel-Powered Fire Pump	380 hp	May burn distillate fuel oil only containing no more than 0.28% by weight sulfur Distillate fuel usage limited to 4,009 gallons/ month and 32,075 gallons per year CO limited to 2.13 tons/year Nitrogen oxides limited to 9.90 tons/year Particulate matter limited to 0.70 tons/year Sulfur Dioxide limited to 0.65 tons/year VOM limited to 0.81 tons/year Opacity shall not exceed 30% except for one eight-minute period per hour of not more than 60% opacity.
Diesel Fire Pump B	Diesel-Powered Fire Pump	340 hp	
Horizontal Fire Pump	Diesel-Powered Fire Pump	240 hp	
STP[4] Emergency Diesel Generator	Diesel-Powered Generating Set	255 hp	
LAN Server Backup Diesel Generator	Diesel-Powered Generating Set	68 hp	
NSA	Diesel-Powered Generating Set	47 hp	
Admin Building Diesel Generator	Diesel Generator	Small	
0FS03T	Gasoline Above Ground Storage Tank	1,500 Gallon	VOM emissions shall not exceed 0.1 lbs. per hour and 0.44 tons/year
0TO01T	Dirty Turbine Oil Storage Tank	15,000 Gallon	
	Used Oil Storage Tank	2,000 Gallon	
Oil Separator 1	Oil Separator	18,000 Gallon	
Oil Separator 2	Oil Separator	13,000 Gallon	

Table 3.3-9 CPS Permitted Air Emission Sources (Sheet 3 of 3)

Emission Source(1,2)	Description	Capacity Rating	Permit Conditions(3)
Parts Washer	(3) Parts Washers	Large	VOM Usage 0.08 Tons per Month and 0.75 Tons per Year VOM Emissions 0.08 Tons per Month and 0.75 Tons per Year

1. Emission Source unit reference is from Permit No. 039804AAC.
2. Stationary combustion sources also subject to 40 CFR Part 63, Subpart ZZZZ—NESHAP for Stationary Reciprocating Internal Combustion Engines.
3. For a full discussion of air permit conditions, see IEPA Permit No. 039804AAC.
4. Sanitary wastewater treatment lagoon system.

Table 3.3-10 Annual Air Emissions Summary

Year	PM	PM 2.5	PM 10	SO_2	NO_X	CO	VOM
2022	0.22	0.22	0.22	0.04	6.4	1.67	0.25
2021	0.15	0.15	0.15	0.03	4.28	1.11	0.18
2020	0.28	0.28	0.28	0.08	8.25	2.16	0.30
2019	0.21	0.21	0.21	0.11	5.18	1.31	0.29
2018	0.26	0.26	0.26	0.09	7.19	1.87	0.31

Table 3.3-11 CPS Annual GHG Emissions Inventory Summary, 2018-2022[1]

CO₂e Emissions, Metric Tons					
Emission Source	**2018**	**2019**	**2020**	**2021**	**2022**
Direct Emissions[a]	2,070	4,339	5,551	1,246	808
Purchased Electricity[b]	54	47	50	45	61
Workforce Commuting[c]	2,604	2,604	2,604	2,604	2,604
TOTAL	4,728	6,990	8,205	3,895	3,473

(1) GHG calculated emissions are based on the following:
  (a) Includes all emissions from CPS including stationary combustion sources, SF_6, process CO_2, and ODC refrigerants.
  (b) Calculated from electricity receipts.
  (c) Workforce commuting calculations are based on:
    1. Statistical information from the USCB indicates that 5.8 percent of Illinois workers in the Transportation and Warehouse and Utilities Industry carpool to work (USCB 2020e). The number of CPS employees as of September 2022 was 596. Utilizing the 5.8 percent USCB carpool statistic, a value of "561" passenger vehicles per day was utilized.
    2. Based on the EPA's Greenhouse Gas Equivalencies Calculator, the CO_2e/year to be 2,604 metric tons for 561 vehicles (EPA 2021b)
    3. CO_2e means the number of units of another GHG that has the same global warming effect as a single unit of CO_2.
    4. As an example: 25 metric tons of CO_2 emissions have the equivalent global warming effect as a single metric ton of methane emissions. (Based on Table A-1 to Subpart A of 40 CFR Part 98).

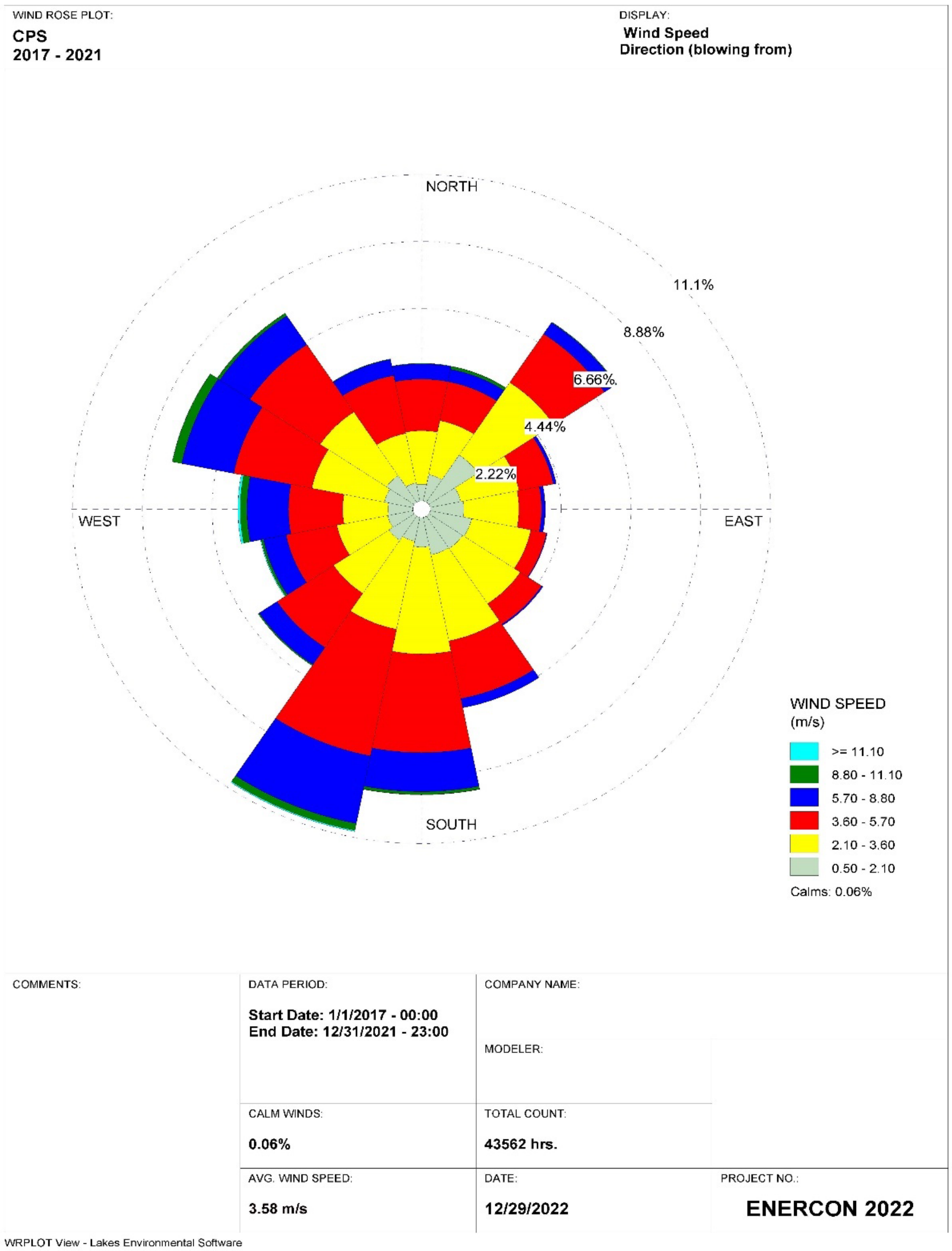


Figure 3.3-1 CPS Wind Rose 2017–2021

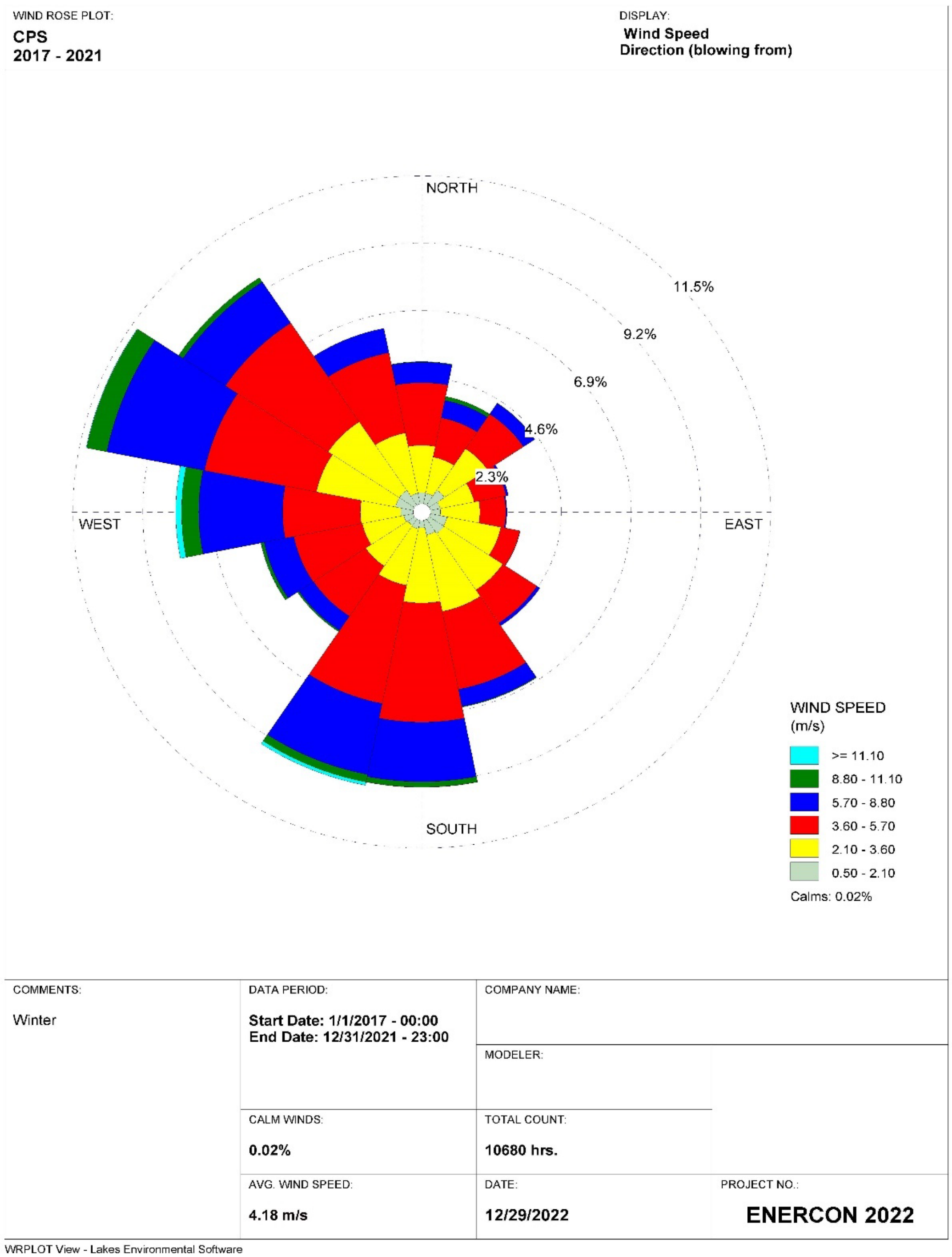
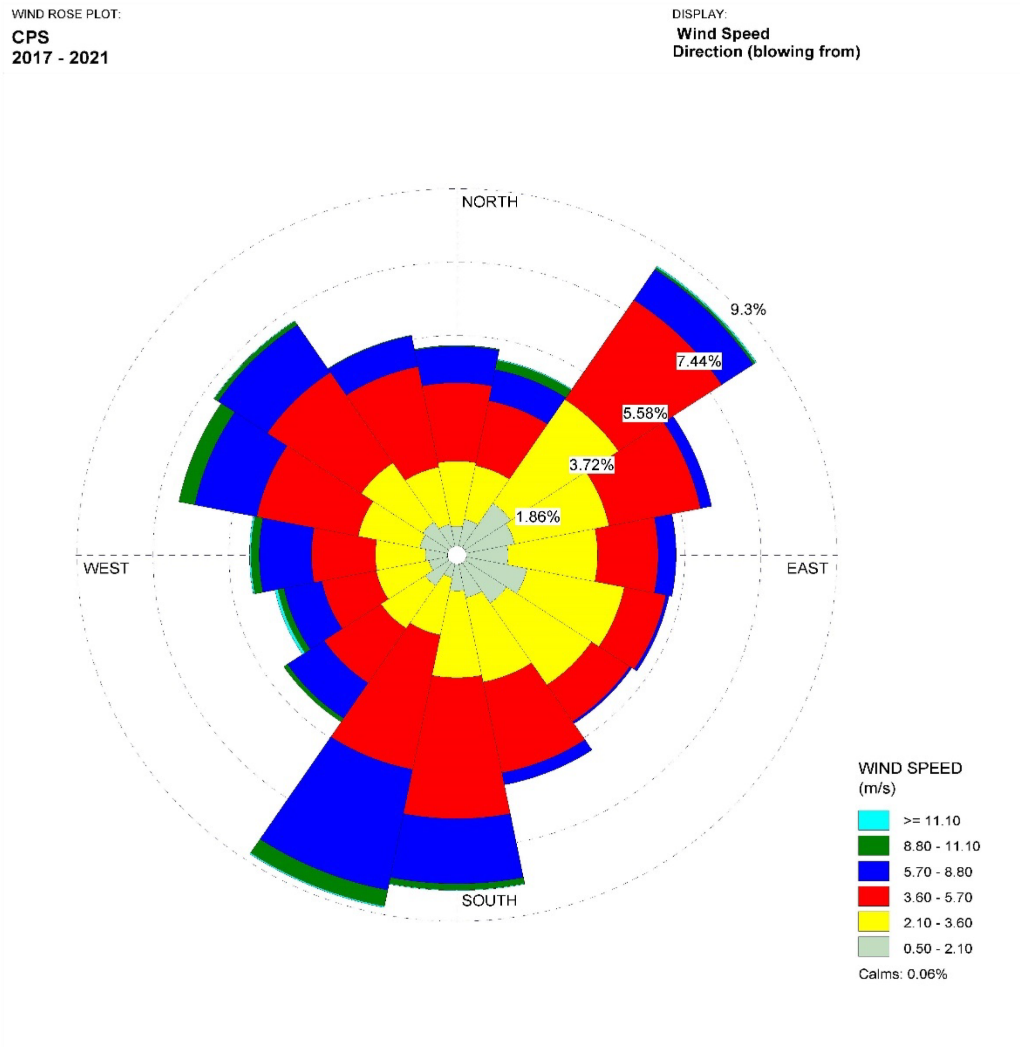


Figure 3.3-2 CPS Winter Wind Rose 2017–2021



COMMENTS: Spring	DATA PERIOD: Start Date: 3/1/2017 - 00:00 End Date: 5/31/2021 - 23:00	COMPANY NAME:	
		MODELER:	
	CALM WINDS: 0.06%	TOTAL COUNT: 10961 hrs.	
	AVG. WIND SPEED: 3.94 m/s	DATE: 12/29/2022	PROJECT NO.: ENERCON 2022

WRPLOT View - Lakes Environmental Software

Figure 3.3-3 CPS Spring Wind Rose 2017–2021

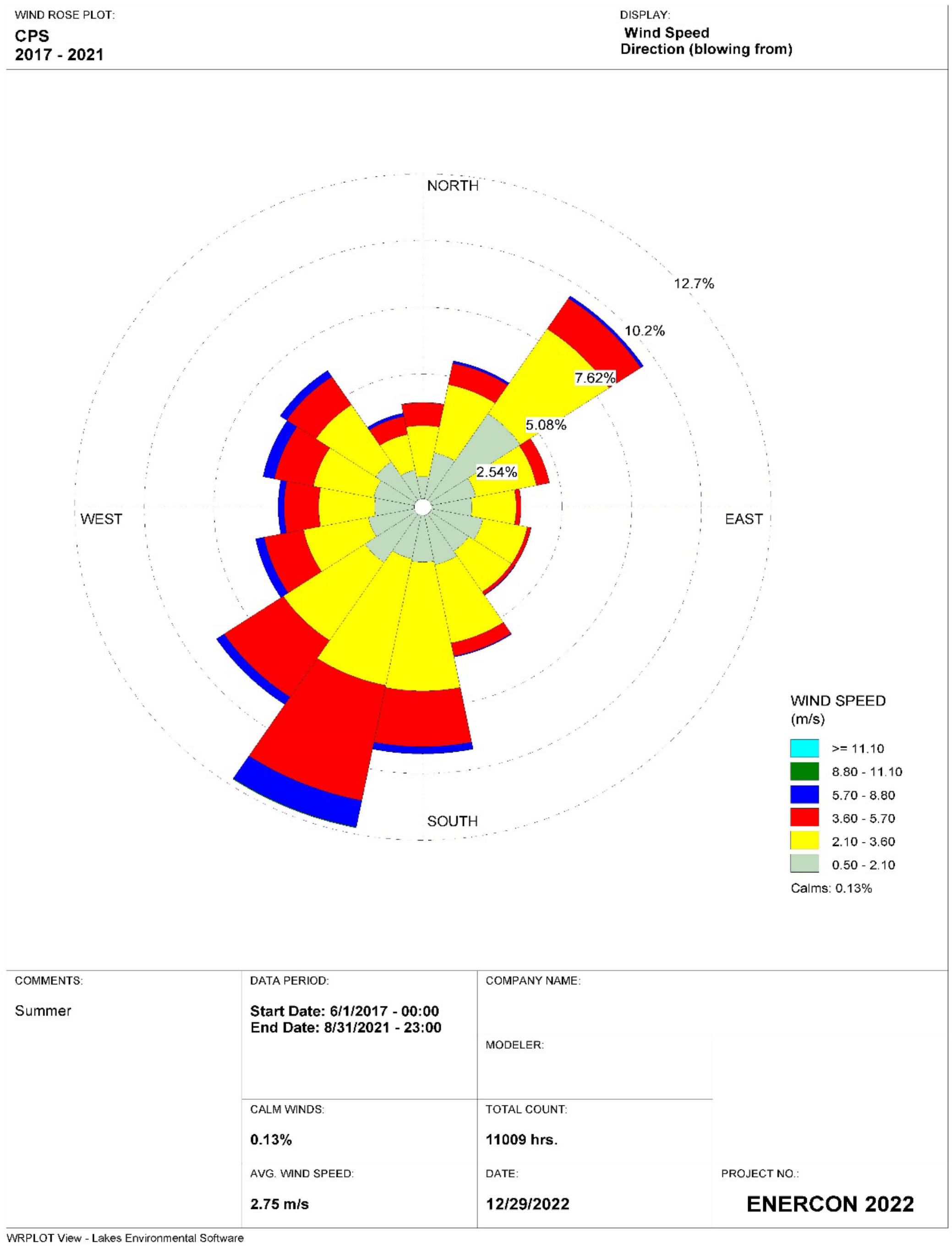


Figure 3.3-4 CPS Summer Wind Rose 2017–2021

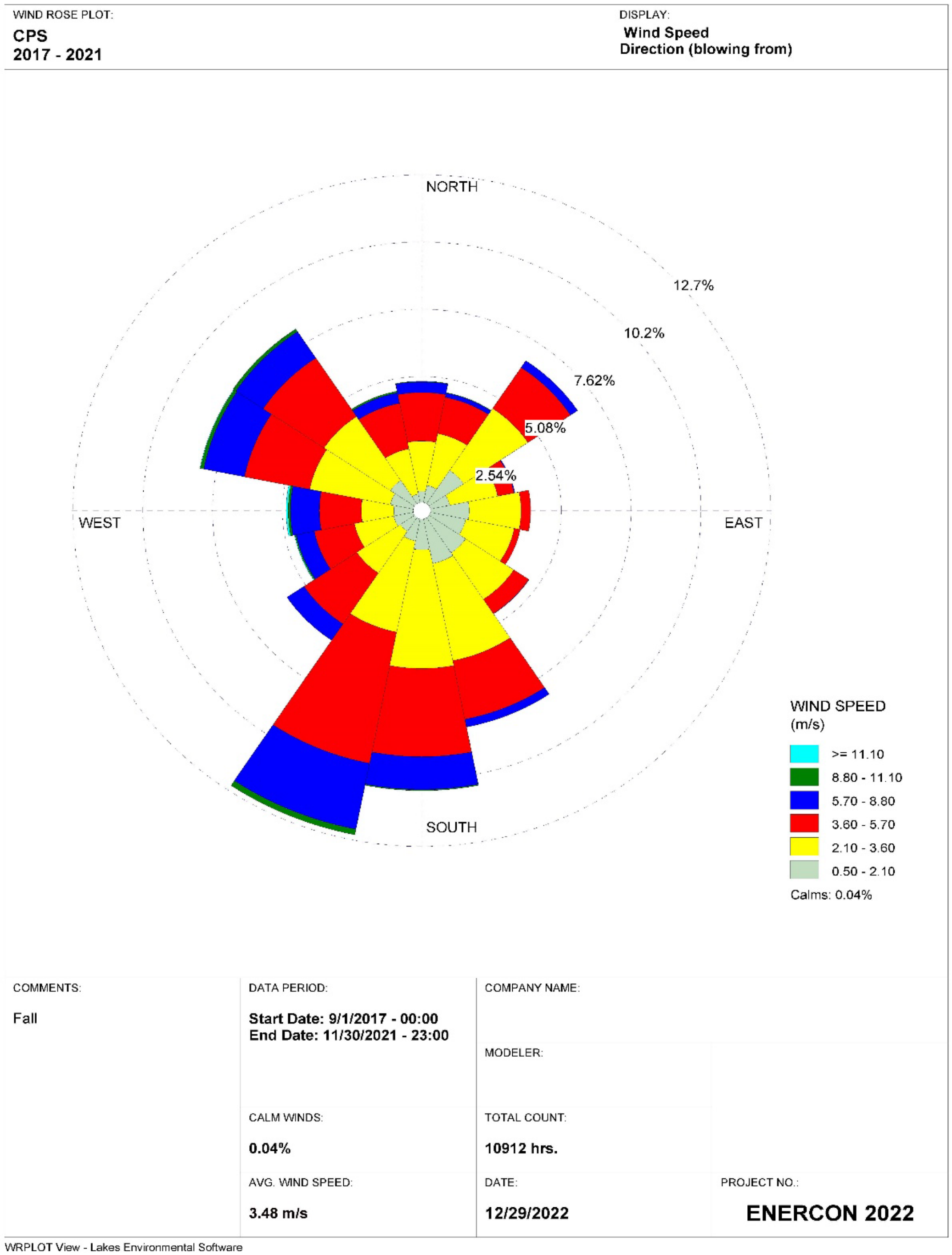


Figure 3.3-5 CPS Fall Wind Rose 2017–2021

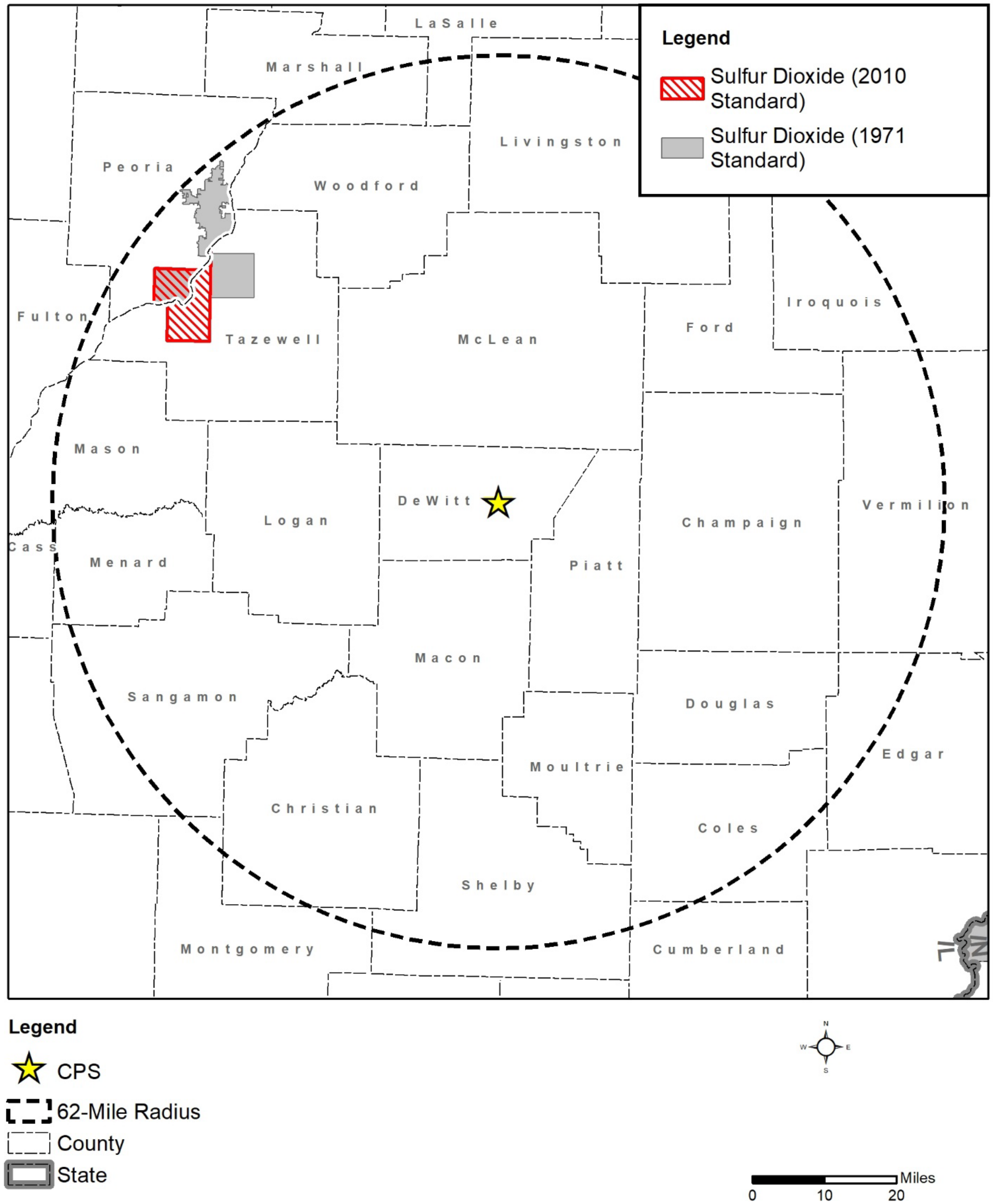


Figure 3.3-6 CPS Maintenance Areas

3.4 Noise

Noise is produced at CPS from industrial station operations and activities. Industrial background noise at CPS is generally from the operation of pumps, transformers, turbines, generators, helper cooling towers, and switchyard equipment. (NRC 2006)

CPS is located in DeWitt County in central Illinois, just over 6 miles east of the city of Clinton, the county seat of DeWitt County. The station in its entirety is zoned for transportation and industrial use. The closest communities to CPS include DeWitt, Lane, Weldon, and Clinton. (NRC 2006) DeWitt County is primarily rural with over 88 percent of land designated as Agricultural, three percent as Ag-Residential, and 0.1 percent as Commercial Agricultural. CEG owns over 13,000 acres in the county as part of CPS and the surrounding station, which includes Clinton Lake. (DC 2018) The nearest residence is located approximately 0.73 miles (1.17 kilometers) southwest of the station (EGC 2021a).

Because CPS is located in a rural area, it is unlikely that noise levels would adversely affect offsite residences. This is further substantiated by the fact that there has been only one noise complaint by the public during the last 5 years (2018−2022). On August 12, 2021, a nearby resident shared a noise complaint with a CPS representative regarding the sound level generating from the new helper cooling towers. CEG has a fleetwide procedure to provide personnel with regulatory requirements related to the Noise Control Act of 1972 (42 USC 4901), the Quiet Communities Act (42 USC 4913), and noise control regulations of 40 CFR 201-211. Once a complaint is received it is documented in accordance with CEG Corrective Action Program procedures and site communication is notified. Prior to startup of the 2022 season, CPS conducted a noise survey to determine if sound levels when both helper cooling towers are in operation exceed regulatory requirements. CPS safety took decibel readings next to both trains of the cooling towers and established a maximum reading of 83 A-weighted decibels (dBA). The reading is lower than the allowed permissible exposure limit (PEL) of 85 dBA for an 8-hour time weighted average and does not violate local ordinances or zoning regulations.

In 2020, as a result of an employee’s concern regarding noise levels in the fuel building, CPS conducted a noise level monitoring survey to evaluate the noise levels that workers are exposed to at the station. The monitoring was conducted to compare noise levels at CPS to the Occupational Safety and Health Administration (OSHA) Standard 1926.52, Occupational Noise Exposure. In addition, area noise screening was conducted within employee workstations or in common work areas for the purpose of identifying areas that may exceed the OSHA PEL for noise. A total of nine workers were equipped with Svantek 104IS personal noise dosimeters for continuous noise level monitoring during an 8-hour work period. According to the personal noise monitoring data, the noise levels for the nine workers sampled within designated areas were all below the OSHA PEL of 90 dBA for an 8-hour time weighted average. The areas within CPS that were monitored for occupational noise were the fuel building, containment building, control building, turbine building, service building, and the auxiliary building. It has been determined that the loudest onsite facility is the turbine building with an average decibel read of 86 dBA.

CPS monitors noise at and around the station for occupational and ambient effects on an as-needed basis. Noise levels at CPS are anticipated to remain the same as under current operating conditions during the proposed LR term.

3.5 Geologic Environment

3.5.1 Regional Geology

The CPS site is in eastern Illinois within the Central Lowlands physiographic province (Figure 3.5-1). The Central Lowlands province is the largest of the physiographic provinces in the contiguous United States, spanning 585,000 square miles. This largely level region rises less than 1,000 feet above mean sea level (MSL) in the east to less than 2,000 feet to the west. The Central Lowlands were subject to repeated Pleistocene glaciations and can be divided into regions based on glacial features, including the Great Lakes, Small Lakes, Driftless Area, Till Plains, Dissected Till Plains, and Osage Plains. Underlying glacial deposits are largely horizontal Paleozoic sandstones, shales, limestones, conglomerates, and coals. (NPS 2022b)

The Central Lowland province is characterized by a low-relief surface formed by glacial till, outwash plains, and glacial-lake plains. Long, low, arcuate ridges, which were formed by recessional moraines and generally are concave to the north, are common features on these plains. The glacial deposits that compose the ridges and plains have completely buried the preglacial topographic features of most of the segment. Parts of the buried bedrock valleys contain unconsolidated deposits of sand and gravel that constitute productive aquifers. (Lloyd and Lyke 1995)

This province is a tectonically stable area characterized by gently dipping sedimentary rock of Paleozoic age overlain by thin Cenozoic deposits of mostly Quaternary-age glacial drift and locally by Mesozoic strata. Beneath the Paleozoic is a basement complex of Precambrian igneous and metamorphic rocks. Intermittent slow subsidence and gentle uplift through the Paleozoic resulted in broad basins (e.g., the Illinois, Michigan, and Forest City Basins) filled with gently dipping sedimentary rocks and in intervening broad arches or highs (e.g., the Kankakee Arch, Mississippi Arch, etc.). Locally, folds and faults have been superimposed on this pattern. CPS is located on the northwest flank of the Illinois Basin, west of the LaSalle Anticlinal Belt. The Paleozoic sedimentary rock sequence is punctuated by several unconformities of regional importance, reflecting widespread advances and withdrawals of the Paleozoic seas across the interior of North America. (EGC 2020a)

CPS is in the Till Plains section of the Central Lowland physiographic province. The terrain aspect of Central Illinois and adjacent Indiana is typical of the province, consisting of undulating, low-relief topography formed by a glacial drift cover whose thickness ranges from a few tens of feet to several hundreds of feet. Much of the Till Plains Section is characterized by landforms of low, commonly arcuate ridges, called moraines, interspersed with relatively flat intermorainal areas. CPS is situated in a sector of the Till Plains Section known as the Bloomington Ridged Plain. (EGC 2020a)

CPS is located within the Illinois Basin, west of the LaSalle Anticlinal Belt. The regional geology is composed of approximately 250 feet of Quaternary overburden glacial deposits. These glacial deposits are largely Wisconsinan, Illinoian, and pre-Illinoian deposits. The deposits' features include alluvial outwash, windblown loess, lakebed clays or silts, and ice-deposited till.

The LaSalle Anticlinal Belt is more than 200 miles long and extends from a point north of the Illinois River, near LaSalle, to the Indiana state line on the Wabash River south of Vincennes. Its closest approach is 15 to 20 miles to the east of CPS. The LaSalle Anticlinal Belt is a complex structure consisting in many places of *en echelon* north-south trending folds and troughs. Dips on the west flank of the belt may be up to 2,000 feet per mile (approximately 20°). Dips on the eastern flank are 25 to 50 feet per mile (approximately .5°). (EGC 2020a) There are no known faults or folds of design significance at or near CPS (EGC 2020).

The Illinois Basin is an oval-shaped basin. The major axis of the basin, trending approximately N 25° W, is approximately 350 miles long and the minor axis is approximately 250 miles long. The deepest part of the basin, the Fairfield Basin, is in southeastern Illinois. Sediments in the Fairfield basin are 12,000 to 14,000 feet thick. (EGC 2020a) The Illinois Basin began to form in Cambrian time and continued to develop intermittently until the end of the Paleozoic (EGC 2020a).

Overburden deposits consisting of Quaternary-age glacial drift and stream alluvium overlie thick sequences of Paleozoic sedimentary rock throughout most of Illinois and adjacent Indiana. In the extreme northern part of Illinois, the drift rests principally upon Ordovician and Silurian formations. Elsewhere, the uppermost strata beneath the glacial drift consist mainly of Pennsylvanian-age (Late Paleozoic) rocks. Most of the Paleozoic formations in Illinois dip gently (about 25 feet per mile) with some thickening toward the axis of the Illinois Basin in southeastern Illinois. (EGC 2020a) Postglacial stream development dissected the drift mantle and in some areas along the main valleys, preglacial bedrock has been exposed by erosion; however, there are no bedrock exposures near CPS. Elevation on the general drift surface between drainageways in the general area of CPS average about 740 feet above sea level. (EGC 2020a)

The CPS area consists of a gently rolling upland developed on ground moraine that has been dissected by the southwest-flowing Salt Creek and the North Fork of Salt Creek. Topographic relief varies from approximately 10 feet on the upland to a maximum of about 80 feet between the upland and the valley bottoms. Strata underlying CPS consists of an estimated 170 to 360 feet of Quaternary overburden, which is largely Wisconsinan, Illinoian, and pre-Illinoian aged glacial deposits, resting on an essentially flat-lying Pennsylvanian aged shales, sandstones, and thin coal beds. (EGC 2020a)

3.5.2 Site Geology

CPS is within the Central Lowlands physiographic province (Lloyd and Lyke 1995), which is characterized by a low-relief surface formed by glacial till, outwash plains, and glacial lake plains. The glacial materials overlay consolidated Paleozoic-age materials throughout most of the province. Loess and alluvium along the floodplains overlay glacial drift deposits. The glacial drift is generally more than 61 m (200 feet) thick beneath the site. (NRC 2006)

CPS is within the Bloomington Ridged Plain physiographic subsection of the Till Plains Section. The main station is in areas of uplands, consisting of Wisconsinan-age ground moraine that have been dissected by the Salt Creek and the North Fork of the Salt Creek. The uplands consist of gently rolling ground moraine, located just east of the Shelbyville end moraine, with local relief of about 10 feet, except near the drainageways. Average elevation of the uplands is approximately 740 feet above MSL. (EGC 2020a)

The general stratigraphy underlying CPS consists of overburden deposits, about 225 and 360 feet in thickness in the upland areas, resting on Pennsylvanian-age bedrock. The overburden materials, in order of increasing age, consist of stream alluvium, windblown loess, and glacial drift. Colluvium and glacial outwash are also present. (EGC 2020a)

The overburden deposits underlying CPS are described below stratigraphically from top (youngest) to bottom (oldest). In general, the pre-Illinoian strata occur above depths of 35 feet below ground surface (bgs) (700 feet MSL). The Illinoian Glasford Formation is encountered at depths below 35 feet bgs and ranges in elevation from approximately 570 to 700 feet MSL. Older Kansan-age lacustrine deposits (lake deposits) and till were encountered beneath the Glasford Formation from elevations that ranged from approximately 500 to 570 feet MSL.

- The Cahokia Alluvium derives from stream alluvium and recent channel deposits composed of poorly sorted silt, clay, and silty sand with sand and gravel lenses (EGC 2020a).
- The Henry Formation underlies the alluvium and consists of glacial outwash deposits composed of yellow-brown fine to coarse sand and gravel, pockets of silty-clayey material, and a basal lag gravel. These Cahokia Alluvium and Henry Formation deposits range up to 35 feet in thickness and are in the valleys of Salt Creek and North Fork of Salt Creek. (EGC 2020a)
- The Richland Loess consists of a brown clayey silt with a trace of sand and is present in the uplands at CPS approximately 5-to-10 feet thick (EGC 2020a).
- The Wisconsinan Wedron Formation derives from glacial drift deposits composed of stiff to very stiff clayey sandy silt till that is brown in color in the upper oxidized zone but grades to gray in the unoxidized zone. Discontinuous lenses of stratified sand, silt, or gravel are randomly interbedded within the till of the Wedron Formation. It is 20 to 55 feet thick in the CPS area where it has not been partially removed by erosion. (EGC 2020a)
- The Wisconsinan Robien Silt is a dark colored silt rich in organic material. It is present over much of the CPS area and may be up to 2 feet thick, although locally it may be

absent due to erosion. The Farmdale Soil (described in Section 3.5.3) is developed in the Robein Silt. This formation is restricted to the uplands at CPS. (EGC 2020a)

- The Illinoian Glasford Formation is present under valleys. The weathered part of the Glasford Formation is leached, characteristically black, dark brown, green, or bluish-green and is 10 to 15 feet thick in the CPS area. The weathered materials are dominantly glacial till consisting of silty clay and clayey silt, but locally they may be discontinuous lenses of silts, sands, or sandy silts interbedded within the glacial till of the Glasford Formation. The boundary between the weathered and unaltered Glasford Formation is marked by the occurrence of calcareous glacial till. The unaltered Glasford Formation at CPS ranges in thickness from 90 to more than 140 feet. It is dominantly a hard, gray-brown sandy silt till. Discontinuous layers of stratified sand, gravel, or silt, up to 2-to-3 feet in thickness, may be interbedded within the till in the uppermost part of the unaltered Glasford Formation. (EGC 2020a)
- The Kansan Banner Formation is a complex assemblage of glacial materials consisting of gray to brown clay till, which is occasionally sandy, reworked till and outwash, and glaciolacustrine gray silt. The sequence varies in thickness from 10 to 105 feet. The Mahomet Sand Member of the Banner Formation, which is a clean sand and gravel deposit, is generally the contact between the overburden and bedrock. In some areas of CPS, however, including beneath the power block, Illinoian glacial deposits lie in direct contact with bedrock. The thickness of the Mahomet Sand Member ranges from zero to 140 feet thick. (EGC 2020a)

The bedrock surface is an erosional surface, and in the CPS area, there is no general relationship between Paleozoic structures and bedrock topography (EGC 2020). The bedrock surface varies in elevation from 360 to 510 feet MSL (EGC 2020a). A map of bedrock geology at CPS is shown in Figure 3.5-2. The Pennsylvanian bedrock beneath CPS is characterized by sharp vertical changes in rock type and lateral persistence of limestone or coal units, where they have not been removed by erosion. Beneath CPS, the elevation of the top of bedrock is approximately 550 feet MSL. Regional marker beds encountered at CPS are the Shoal Creek Limestone Member, the No. 8 Coal Member, and the No. 7 Coal Member. (EGC 2020a)

The uppermost Pennsylvanian strata are part of the Bond Formation of the McLeansboro Group. The Shoal Creek Limestone Member is a marker bed at the base of the Bond Formation. The Shoal Creek Member is found beneath the power block and UHS in areas where the Pennsylvanian bedrock has not been eroded below an elevation of 495 feet MSL. The Shoal Creek Limestone Member is a fine to coarse crystalline limestone with irregular shale partings; in the upper portion of the unit, there are numerous open and clay-filled weathered bedding planes. (EGC 2020a)

Underlying the Bond Formation is the Modesto Formation, which is also part of the McLeansboro Group. Three distinctive units of the Modesto Formation were identified at CPS. The upper part of the formation contains an unnamed limestone unit that is contiguous across CPS in areas where the bedrock has not been eroded below an elevation of 472 feet MSL. It is an argillaceous, fine crystalline limestone, which is variable in thickness, and contains interbedded shale. (EGC 2020a)

The No. 8 Coal Member of the Modesto Formation is 1 foot thick at CPS and was encountered at 431 feet MSL. Below 424 feet MSL, the Modesto Formation is predominantly siltstone and shale. A limestone bed was encountered in one location, however, at 360 feet MSL. (EGC 2020a)

Underlying the McLeansboro Group is the Pennsylvanian-age Kewanee Group. The uppermost formation in the Kewanee Group is the Carbondale Formation, whose top is marked by the No. 7 Coal Member. This unit is 2.5-to-3 feet thick in the CPS area. (EGC 2020a)

Underlying the No. 7 Coal Bed Member is about 440 feet of Pennsylvanian-age strata consisting principally of cyclothems. Below the Pennsylvanian are approximately 560 feet of Mississippian shale and limestone underlain by 180 feet of Devonian limestone and shale. Subsurface investigations underlying CPS terminated in Silurian dolomite. (EGC 2020a)

Approximately 450 feet of Siluran-age sediments underlie CPS. Much of the Illinois Basin, including the CPS area, was continuously beneath shallow seas during the Silurian Period. Deposition in these shallow seas consisted primarily of carbonates and reefs developed in some areas. Regional data suggest that carbonate deposition continued from Silurian into Devonian time. (EGC 2020a)

Approximately 1,000 feet of Ordovician sediments underlie CPS. The Ordovician Period began with a transgression of the sea. General conditions favored the accumulation of calcareous deposits. At the close of Early Ordovician time, the sea receded, and a prolonged period of erosion was initiated. Later, the readvancing sea deposited a considerable quantity of fine to medium sand (the St. Peter Sandstone), followed by a thick sequence of calcareous deposits, and ending with accumulations of silt and clay. (EGC 2020a)

Approximately 3,100 feet of Late Cambrian sediments underlie CPS. The CPS area was submerged during Late Cambrian time. The first deposits in the advancing sea were coarse sand and fine pebbles, followed by finer sand, dolomite, and shale with an increasing amount of calcareous material. Before the close of Cambrian time, the seas cleared and chemical and/or organic precipitates, which formed carbonate rocks, were deposited. At the close of Cambrian time, the site area was uplifted. This was followed by a brief period of erosion. (EGC 2020a)

The elevation of the Precambrian basement in the CPS vicinity is estimated to be approximately 6,000 feet MSL at a depth of approximately 6,700 feet bgs. Data from the CPS region suggest that Precambrian rocks in Illinois are igneous, composed of granite, rhyolite, and associated rocks that formed in the interval from 1.1 to 1.4 billion years ago. The Precambrian basement in Illinois underwent a long period of erosion lasting from Late Precambrian time to Cambrian time. Consequently, the Precambrian surface is, in part, an erosional surface that may have several hundred feet of relief. (EGC 2020a)

Columnar geologic cross sections are shown in Figure 3.5-3a, Figure 3.5-3b, and Figure 3.5-3c.

Major power block structures were constructed on mat foundations underlain by compacted fill resting on hard Illinoian till. The cooling lake was formed by construction of an earth-filled dam across Salt Creek downstream of its confluence with the North Fork of Salt Creek. (EGC 2020a)

There is no known karst development at CPS or within the vicinity. There are no known instances of, or potential possibilities for, surface or subsurface subsidence, uplift, or collapse resulting from the activities of man within the site area. Present and former activities within the site area have included the removal of sand and gravel and the domestic use of groundwater. Sand and gravel production has been limited to surficial mining operations, and thus no hazard is posed to the station site because of subsidence. There are no large uses of groundwater, nor any industrial disposal wells in this area. No surface subsidence or response due to groundwater withdrawals have been reported near the site. (EGC 2020a) CPS documented the occurrence and repair of four small sinkholes; however, these features were unrelated to karst development. There are no karst features in the CPS area. These features, which are not significant in size, were reported outside of the PA to the west, north, and south. The formation of these features is believed to be related to abandoned underground piping and soil washout.

Two oil fields are located within 15 miles of CPS. The Wapella East field is located approximately 6 miles northwest of the site, and the Parnell field is located approximately 7 miles northeast of the site. Both oil fields are located on domal structures along the Downs Anticline. There have been no instances of uplift, subsidence, or collapse associated with these oil fields, and no hazard is posed to the station site because of these oil field developments. (EGC 2020a)

Five gas storage projects are located within 35 miles of CPS. The Hudson gas storage project is located approximately 27 miles north of the site; the Lexington gas storage project is located approximately 30 miles north of the site, and the Lake Bloomington project is located approximately 34 miles north of the site. Each of these gas storage projects was developed by the Northern Illinois Gas Company, and for each of these projects, the storage reservoir is the Cambrian-age Mt. Simon Sandstone. The Manlove gas storage project is located approximately 23 miles east-northeast of the site. This gas storage project is operated by The Peoples Gas, Light, and Coke Company. The storage reservoir is the Cambrian-age Mt. Simon Sandstone. The Lincoln gas storage project is located approximately 30 miles west of the site. The Central Illinois Light Company operates this gas storage project. The storage reservoir is in Silurian dolomite. There have been no instances of uplift, subsidence, or collapse associated with these gas storage projects, and no hazard is anticipated to the station site because of these gas storage projects. (EGC 2020a)

3.5.3 Soils

3.5.3.1 Onsite Soils and Geology

Between glacial periods, the climate returned to more temperate conditions. As the glacial and glacially derived sediments were exposed, weathering processes began to alter them, and soils were formed. The thickness and character of the resulting soils are largely a function of climate, topographic position, vegetation, and duration of the interglacial stage. (EGC 2020a)

Soil units that occur within the CPS EAB are described in detail in Table 3.5-1 and shown in Figure 3.5-4. The EAB is entirely within the station property and is the area encompassed by a circle of 975 meters radius centered on the station standby gas treatment system vent (ECG 2020). The soils are also summarized below. Approximately 83.22 percent of the EAB has soil cover. The remaining 16.78 percent of the EAB is covered in water. (USDA 2022)

- Keomah silt loam, 0−2 percent slopes
- Miami silt loam, 10−18 percent slopes, eroded
- Ipava silt loam, 0−2 percent slopes
- Sable silty clay loam, 0−2 percent slopes
- Birkbeck silt loam, 2−5 percent slopes
- Birkbeck silt loam, 5−10 percent slopes
- Rozetta silt loam, 2−5 percent slopes, eroded
- Russell silt loam, Bloomington Ridged Plain, 5−10 percent slopes, eroded
- Urban land
- Senachwine silt loam, 18−35 percent slopes
- Senachwine silt loam, 35−60 percent slopes
- Buckhart silt loam, till substratum, 2−5 percent slopes
- Orthents, loamy, undulating
- Orthents, loamy, 2−20 percent slopes
- Miscellaneous water
- Water

Site preparation and earthwork consisted of stripping, excavating, dewatering, and backfilling operations to attain a nominal station grade at approximately elevation 736 feet. All topsoil was removed prior to general excavation operations. (EGC 2020a) The excavation extended from existing grade to the Illinoian till of the unaltered Glasford Formation at approximately elevations 680 to 683 (EGC 2020a).

Controlled compacted granular fill, Type B material, was placed to bring the base elevation of the excavation up to the grade elevations for the foundations of the various station structures (EGC 2020a). The fill was overlain by about 5 to 10 feet of clayey sand and clayey silt (EGC 2020a). A concrete mud mat was poured over the Type B structural fill to prevent rutting, erosion, and to provide a firm working area for the mat foundation. Type A cohesive material was used as backfill material over the granular material above approximately elevation 720 feet. (EGC 2020a)

The compacted fill bears directly on the underlying hard Illinoian glacial till strata, which consists of gray to brown clayey silt with occasional gravel-sized particles. The underlying lacustrine and pre-Illinoian soils are hard and consist of clayey and sandy silts with occasional gravel-sized particles. These soils are immediately underlain by thinly bedded Pennsylvanian limestone and shale. (EGC 2020a)

3.5.3.2 Erosion Potential

Because CPS has been operational since 1987, stabilization measures are already in place to prevent erosion and sedimentation impacts to the site and vicinity. Based on information from the U.S. Department of Agriculture (USDA), the following soil units listed in Table 3.5-1 subject to erosion have severe erosion potential: Russell silty clay loam, Senachwine silt loam 18−35 percent slopes, Senachwine silt loam 35−60 percent slopes, and Orthents 2−20 percent slopes. These soils comprise 11.38 percent of the mapped area. These soils are mapped in the EAB in narrow bands along Clinton Lake and in small patches in unimproved areas south and southeast of the station structures. The remaining areas in the EAB have slight to moderate erosion potential. (USDA 2022)

CPS maintains and implements a Stormwater Pollution Prevention Plan (SWPPP) that identifies potential sources of pollution reasonably expected to affect the quality of stormwater, such as erosion, and identifies practices to prevent stormwater runoff to Clinton Lake. The CPS SWPPP implements and maintains BMPs to manage and divert stormwater to prevent an uncontrolled discharge. CPS minimizes the exposure of industrial activities to rain, snow, snowmelt, and runoff. The facility cleans exposed areas that are potential sources of pollutants, including trash containers and adjacent areas, material storage areas, and material loading/unloading areas. The facility also regularly inspects, maintains, and repairs structural stormwater controls, industrial equipment, and systems, and prevents spills with inspections, secondary containment, and containers in good condition.

The use of specific BMPs will be evaluated annually based on the results of the annual inspection. Additional BMPs would be implemented if deemed necessary.The SWPPP is reviewed and revised, if necessary, under the following conditions:

- Whenever there is a change in construction, operation, or maintenance that may affect the discharge of significant quantities of pollutants

- A quarterly visual observation or annual facility inspection indicated that an amendment is needed
- A discharge violates a condition of the NPDES permit
- The facility has not achieved the general objective of controlling pollutants in stormwater discharges.

3.5.3.3 Prime Farmland Soils

The USDA's Natural Resources Conservation Service maps show that approximately 12.99 percent of the EAB is considered prime farmland, prime farmland if drained, or farmland of statewide importance. Soil units within the EAB designated as prime farmland are identified in Table 3.5-1. Farmland soils total approximately 39.36 percent of the CPS site. (USDA 2022) As described in Section 3.2, however, there are active land leases within the CPS site boundary for agricultural and pastureland use. These areas would most likely still be considered prime farmland even though they are part of the property owned by CEG. CPS is not subject to the Farmland Protection Policy Act (FPPA) because the act does not include federal permitting or licensing for activities on private or nonfederal lands.

3.5.4 Seismic History

The CPS site and the vast majority of the 200-mile radius site region lie within the Central Stable Region of the North American Continent. The Central Stable Region tectonic province is generally noted for its lack of significant seismic activity. This region is characterized by a relatively thin veneer of sedimentary rocks overlying a crystalline basement. These areas were deformed principally by movements that occurred as tectonic activity during the Paleozoic resulting in a series of gentle basins, domes, and other structures. Since the end of the Paleozoic, the area has remained generally quiescent. A few square miles of the southernmost area of the CPS region overlaps the Mississippi Embayment region of the Gulf Coastal Plain Tectonic Province. (EGC 2020a)

CPS is located within the Illinois Basin. The most significant nearby structure is the Downs Anticline, which is genetically related to the LaSalle Anticlinal Belt. The Downs Anticline is a small flexure trending parallel to the LaSalle Anticlinal Belt north and east, 5 to 10 miles from CPS. (EGC 2020a)

No tectonic folding or faulting was observed in the Pleistocene deposits exposed in the excavations at the CPS site, including the Robein Silt. No faulting has been recognized in association with the foregoing structural features either from aerial photographs, ERT imagery, geophysical, studies, borehole control, or excavation mapping. The glacial materials are devoid of lineaments or off-sets suggestive of faulting. Even if the bedrock unit elevation differences could be attributed to structural deformation, the relatively flat-lying and undeformed Pleistocene drift overlying bedrock demonstrates that the tresses that would have been responsible for the deformation have been inactive since at least pre-Pleistocene time. The Downs Anticline and its associated axial domes are stable and are of no structural significance at CPS. There is no evidence for surface faulting at CPS or within 200 miles of CPS. Further, faults that have been mapped in Illinois have shown no sign of movement during Quaternary time. There are no capable faults within 200 miles of the site. The closest proposed fault to CPS is the Tuscola Fault, postulated to trend north-south, approximately 20 miles east of CPS. The existence of this fault has not been accepted by the Illinois State Geological Survey (ISGS). The nearest confirmed fault is the Sandwich Fault Zone, located approximately 90 miles northeast of CPS. The last movement on the Sandwich Fault Zone occurred during the interval from Post-Silurian to Pre-Pleistocene time, probably in the late Paleozoic. (EGC 2020a)

The magnitude of a seismic event is described by two methods: the modified Mercalli (MM) intensity scale and the Richter magnitude scale. The MM intensity is an estimate of the amount of damage caused at a site by an earthquake. The Richter magnitude scale is an approximate measure of the total amount of energy released by an earthquake. Accurate locations for earthquake epicenters have been available since the installation of modern seismographs in the region. Without seismographs, earthquakes were described using the MM intensity.

The North Central United States is among one of the least seismically active areas of the United States. Since this area has been populated for almost 200 years, it is likely that most earthquake events of Intensity VI and all events of Intensity VII or larger on the MM scale have been reported. (EGC 2020a) In the Central Stable Region tectonic province, the largest seismic events are generally of MM VII. (EGC 2020a)

There have been no historically reported earthquakes within 5 miles of CPS (EGC 2020). There is no record of earthquakes with an Intensity of VIII or greater within 200 miles of the site. The greatest earthquakes occurring within 200 miles of CPS are listed below. These events had epicentral intensities of MM VII. (EGC 2020a)

- May 26, 1909 – S. Beloit, Illinois
- July 18, 1909 – central Illinois (Havana)
- September 27, 1909 – southeastern Illinois
- November 9, 1968 – southern Illinois

The greatest intensity induced at CPS by these four earthquakes was MM V. The closest occurrence of an epicentral intensity VI to the site was at approximately 100 miles from CPS. Therefore, the maximum intensity experienced at CPS from any earthquake within a 200-mile radius of CPS was MM V. (EGC 2020a)

Within 200 miles of CPS, the following tectonic provinces or parts of tectonic provinces are found: the Eastern Stable Platform (site province), the Michigan Basin, Central Province, Appalachian Plateau province, and the Northern Valley and Ridge Province (EGC 2020a). CPS is in the Eastern Stable Platform Province, where seismic activity is relatively low. Within 200 miles of the site, only two zones of moderate seismic activity can be found. The first is located 160 miles away, in the same province, and is correlated to the Clarendon-Linden structure, while the second, in the Central Province, about 185 miles away near Anna, Ohio, is probably tied to local basement structures in that area. Within this context, the earthquake potential at the site is low, as related to the hypothetical occurrence of an Intensity VI (MM). Such an intensity is estimated from the maximum earthquake, not correlated to structure, experienced in the site province. (EGC 2020a)

Earthquake epicenter locations of seismic events greater than intensity IV/magnitude 3.0 within a 248.5-mile (400-kilometer) radius of CPS from 1970 through May 2023 are listed in Table 3.5-2 and shown in Figure 3.5-5 (USGS 2022a; USGS 2023a). Two of the seismic events that occurred were caused by explosions. None of the seismic events were within 50 miles of CPS.

The national seismic hazard map from the U.S. Geological Survey (USGS) shows that the CPS site is in a region with a 2 percent in 50 years (once in 2,500 years) probability of exceeding a peak ground acceleration between 0.1 and 0.14g (Rukstales and Petersen 2019).

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 1 of 6)

Map Unit Symbol[(a)]	Soil Unit Name	Description	Farmland Designation
17A	Keomah silt loam, 0 to 2 percent slopes	The Keomah component makes up 0.06% of the EAB. Slopes are 0-2%. This component is on ground moraines. The parent material consists of loess. Depth to a restrictive layer is more than 80 inches. The drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low to moderately high. Available water to a depth of 11.2 inches is high. This soil is not flooded. It is not ponded. The frost-free period is 165 to 190 days. Depth to the water table is about 6 to 24 inches. Non-irrigated land capacity classification is 2w. The soil does not meet hydric criteria. Erosion potential is slight.	Prime farmland if drained
27D2	Miami silt loam, 10 to 18 percent slopes, eroded	The Miami component makes up 0.84% of the EAB. Slopes are 10-18%. This component is on ground moraines. The parent material consists of loess over till. Depth to a restrictive layer is 24 to 40 inches. The drainage class is moderately well-drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 4.9 inches is low. Runoff class is medium. This soil is not flooded. It is not ponded. The frost-free period is 160 to 180 days. Depth to the water table is 24 to 40 inches. Non-irrigated land capacity classification is 4e. The soil does not meet hydric criteria. The soil does not meet hydric criteria. Erosion potential is severe.	Farmland of statewide importance
43A	Ipava silt loam, 0 to 2 percent slopes	The Ipava component makes up 0.4% of the EAB. Slopes are 0-2%. This component is on ground moraines. The parent material is loess. Depth to a restrictive layer is more than 80 inches. The drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 11.6 inches is high. This soil is not flooded. It is not ponded. The frost-free period is 160 to 190 days. Depth to the water table is more than 80 inches. Non-irrigated land capacity classification is 1. The soil does not meet hydric criteria. Erosion potential is slight.	All areas are prime farmland

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 2 of 6)

Map Unit Symbol[(a)]	Soil Unit Name	Description	Farmland Designation
68A	Sable silty clay loam, 0 to 2 percent slopes	The Sable component makes up 2.26% of the EAB. Slopes are 0-2%. This component is on swales. The parent material consists of loess. Depth to a restrictive layer is greater than 80 inches. The drainage class is poorly drained. Water movement in the most restrictive layer is moderately high to high. Available water to a depth of 10.5 inches is high. This soil is not flooded. It is frequently ponded. The frost-free period is 140 to 185 days. Depth to the water table is about 0 to 12 inches. Non-irrigated land capacity classification is 2w. The soil meets hydric criteria. Erosion potential is slight.	Prime farmland if drained
233B	Birkbeck silt loam, 2 to 5 percent slopes	The Birbeck component makes up 5.12% of the EAB. Slopes are 2-5%. This component is on end moraines, ground moraines, and till plains. The parent material consists of loess over loamy till. Depth to a restrictive layer is more than 80 inches. The drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 10.8 inches is high. Runoff class is low. The soil is not flooded. It is not ponded. The frost-free period is 160 to 190 days. Depth to the water table is about 24 to 42 inches. Non-irrigated land capacity classification 2e. The soil does not meet hydric criteria. Erosion potential is moderate.	All areas are prime farmland
233C2	Birkbeck silt loam, 5 to 10 percent slopes, eroded	The Birbeck component makes up 0.55% of the map unit. Slopes are 5-10%. This component is on till plains and moraines. The parent material consists of loess over loamy till. Depth to a restrictive layer is more than 80 inches. The drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 9.1 inches is high. Runoff class is very medium. The soil is not flooded. It is not ponded. The frost-free period is 160 to 185 days. Depth to the water table is about 24 to 42 inches. Non-irrigated land capacity classification 3e. The soil does not meet hydric criteria. Erosion potential is moderate.	Farm of statewide importance

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 3 of 6)

Map Unit Symbol[(a)]	Soil Unit Name	Description	Farmland Designation
279B2	Rozetta silt loam, 2 to 5 percent slopes, eroded	The Rozetta component makes up 1.44% of the EAB. Slopes are 2-5%. This component is on ground moraines. The parent material consists of loess. Depth to a restrictive layer is more than 80 inches. The drainage class is well drained. Water movement in the most restrictive layer is moderately high to high. Available water to a depth of 12.3 inches is very high. The soil is not flooded. It is not ponded. The frost-free period is 175 to 180 days. Depth to the water table is about 48 to 72 inches. Non-irrigated land capacity classification 2e. The soil does not meet hydric criteria. Erosion potential is moderate.	All areas are prime farmland
322C2	Russell silt loam, Bloomington Ridged Plain, 5 to 10 percent slopes, eroded	The Russell component makes up 0.24% of the EAB. Slopes are 5-10%. This component is on ground and end moraines. The parent material consists of loess over loamy till. Depth to a restrictive layer is 40 to 60 inches. The drainage class is well drained. Water movement in the most restrictive layer is moderately low to moderately high. Available water to a depth of 8.7 inches is moderate. Runoff class is medium. The soil is not flooded. It is not ponded. The frost-free period is 155 to 195 days. Depth to the water table is more than 80 inches. Non-irrigated land capacity classification 3e. The soil does not meet hydric criteria. Erosion potential is moderate.	Farmland of statewide importance
533	Urban land	Urban land makes up 34.86% of the EAB. The frost-free period is 140 to 180 days. Non-irrigated land capacity classification 8. The soil does not meet hydric criteria. Erosion potential is not rated.	Not prime farmland

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 4 of 6)

Map Unit Symbol(a)	Soil Unit Name	Description	Farmland Designation
618F	Senachwine silt loam, 18 to 35 percent slopes	The Senachwine component makes up 4.52% of the EAB. Slopes are 18-35%. This component is on end and ground moraines. The parent material consists of a thin mantle of loess or other silty material over calcareous loamy till. Depth to a restrictive layer is more than 80 inches. The drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 7.2 inches is moderate. Runoff class is high. The soil is not flooded. It is not ponded. The frost-free period is 158 to 187 days. Depth to the water table is more than 80 inches. Non-irrigated land capacity classification 6e. The soil does not meet hydric criteria. Erosion potential is severe.	Not prime farmland
618G	Senachwine silt loam, 35 to 60 percent slopes	The Senachwine component makes up 0.25% of the EAB. Slopes are 35-60%. This component is on end and ground moraines. The parent material consists of a thin mantle of loess or other silty material over calcareous loamy till. Depth to a restrictive layer is more than 80 inches. The drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 7.4 inches is moderate. Runoff class is high. The soil is not flooded. It is not ponded. The frost-free period is 173 to 186 days. Depth to the water table is more than 80 inches. Non-irrigated land capacity classification 7e. The soil does not meet hydric criteria. Erosion potential is severe.	Not prime farmland

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 5 of 6)

Map Unit Symbol[(a)]	Soil Unit Name	Description	Farmland Designation
749B	Buckhart silt loam, till substratum, 2 to 5 percent slopes	The Buckhart component makes up 1.81% of the EAB. Slopes are 2-5%. This component is on ground moraines. The parent material consists of very deep loess over till. Depth to a restrictive layer is more than 80 inches. The drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 11.9 inches is high. Runoff class is low. The soil is not flooded. It is not ponded. The frost-free period is 150 to 180 days. Depth to the water table is more than 80 inches. Non-irrigated land capacity classification 2e. The soil does not meet hydric criteria. Erosion potential is moderate.	All areas are prime farmland
802B	Orthents, loamy, undulating	The Orthents component makes up 25.11% of the EAB. Slopes are 1-7%. The parent material consists of earthy fill. Depth to a restrictive layer is more than 80 inches. The drainage class is moderately well drained. Water movement in the most restrictive layer is moderately low to moderately high. Available water to a depth of 8.7 inches is moderate. Runoff class is low. The soil is not flooded. It is not ponded. The frost-free period is 160 to 180 days. Depth to the water table is about 40 to 72 inches. Non-irrigated land capacity classification 3e. The soil does not meet hydric criteria. Erosion potential is moderate.	Not prime farmland
802D	Orthents, loamy, 2 to 20 percent slopes	The orthents component makes up 5.77% of the EAB. Slopes are 2-20%. The parent material consists of a loamy mine spoil or earthy fill. Depth to a restrictive layer is more than 80 inches. The drainage class is moderately well drained. Water movement in the most restrictive layer is moderately low to moderately high. Available water to a depth of 7.2 inches is moderate. Runoff class is medium. The soil is not flooded. It is not ponded. The frost-free period is 160 to 195 days. Depth to the water table is about 40 to 72 inches. Non-irrigated land capacity classification 4e. The soil does not meet hydric criteria. Erosion potential is severe.	Not prime farmland

Table 3.5-1 EAB Soil Unit Descriptions (Sheet 6 of 6)

Map Unit Symbol[(a)]	Soil Unit Name	Description	Farmland Designation
M-W	Miscellaneous water	Miscellaneous makes up 0.84% of the EAB. The frost-free period is 175 to 195 days. Non-irrigated land capacity classification is 8w. The hydric status is not ranked.	Not prime farmland
W	Water	Water makes up 15.93% of the EAB. Water is present in channels, perennial streams, drainageways, lakes, oxbows, and rivers. Non-irrigated land capacity is 8w.	Not prime farmland

(USDA 2022)
a. See Figure 3.5-4 for map unit symbols.

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 1 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
9/15/1972	12:22 AM	41.645	-89.369	4.04 mw	105.39 / 169.61	8 km SSW of Amboy, Illinois
1/7/1973	5:56 PM	37.44	-87.3	3.2 lg	205.82 / 331.23	4 km NW of Sacramento, Kentucky
1/12/1973	6:56 AM	37.93	-90.52	3.2 lg	179.32 / 288.58	3 km ENE of Bonne Terre, Missouri
4/3/1974	6:05 PM	38.592	-88.094	4.5 mb	115.99 / 186.67	3 km W of Parkersburg, Illinois
5/13/1974	1:52 AM	36.71	-89.39	4.3 mb	240.71 / 387.38	7 km S of East Prairie, Missouri
6/5/1974	7:16 PM	38.6	-84.77	3.2 lg	243.06 / 391.16	8 km ESE of Bromley, Kentucky
6/5/1974	3:06 AM	38.62	-89.94	4 mb	122.35 / 196.9	3 km NW of O'Fallon, Illinois
1/10/1975[(b)]	10:31 AM	38.2	-91.035	3.2 lg	180.23 / 290.05	5 km SE of Miramiguoa Park, Missouri
12/11/1976	2:05 AM	38.12	-91.07	4.2 mb	185.69 / 298.84	12 km SE of Sullivan, Missouri
12/13/1976	3:35 AM	37.8	-90.24	3.5 mlg	180.31 / 290.18	9 km SSW of Weingarten, Missouri
1/3/1977	5:56 PM	37.55	-89.79	3.4 mlg	188.09 / 302.7	7 km NW of Oak Ridge, Missouri
6/17/1977	10:39 AM	40.707	-84.582	3.2	227.16 / 365.57	5 km ENE of Rockford, Ohio
6/2/1978	9:07 PM	38.42	-88.46	3.7 mlg	122.53 / 197.19	5 km WSW of Geff, Illinois
9/20/1978	7:24 AM	38.57	-90.28	3.1 mlg	134.95 / 217.17	3 km NE of Wilbur Park, Missouri
12/5/1978	8:48 PM	38.62	-88.36	3.5 mlg	110.05 / 177.11	7 km S of Clay City, Illinois
7/8/1979	7:35 AM	36.89	-89.29	3.1 mlg	227.74 / 366.51	6 km WSW of Wyatt, Missouri
3/13/1980	9:23 PM	37.93	-88.45	3.3 md	156.04 / 251.12	1 km ESE of Broughton, Illinois
3/23/1980	4:38 PM	37.63	-86.69	3.3 mb_lg	209.98 / 337.93	2 km ESE of Fordsville, Kentucky
7/12/1980	6:59 PM	37.265	-86.988	3.1	223.93 / 360.38	7 km NE of Drakesboro, Kentucky
12/1/1980[(b)]	11:55 AM	38.71	-90.84	3.2 md	147.28 / 237.02	3 km E of New Melle, Missouri
4/8/1981	8:53 PM	38.87	-89.38	3.5 md	94.44 / 151.99	3 km SE of Greenville, Illinois
6/9/1981	9:15 AM	37.82	-89.02	3.4 md	162.56 / 261.62	1 km NNE of Herrin, Illinois
5/15/1983	12:16 AM	38.77	-89.57	4.3 md	104.42 / 168.05	2 km ESE of Pierron, Illinois
5/16/1983	9:03 AM	38.48	-92.36	3 md	222.2 / 357.6	7 km S of Lohman, Missouri
7/8/1983	4:41 AM	37.1	-90.94	3 md	240.66 / 387.31	13 km NNE of Van Buren, Missouri
7/10/1983	9:54 PM	37.11	-90.93	3 md	239.79 / 385.91	14 km NNE of Van Buren, Missouri
1/12/1984	9:48 PM	37.59	-89.75	3 md	184.85 / 297.48	3 km WSW of Old Appleton, Missouri

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 2 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
2/13/1984	5:42 PM	37.21	-89.02	3.2 md	204.57 / 329.22	4 km S of Grand Chain, Illinois
2/14/1984	5:56 PM	37.21	-89	3.6 md	204.52 / 329.14	5 km SSE of New Grand Chain, Illinois
2/25/1984	4:01 PM	37.22	-89.01	3 md	203.85 / 328.07	3 km SSE of New Grand Chain, Illinois
4/17/1984	11:44 PM	38.41	-88.48	3.2 md	123.04 / 198.01	7 km NE of Sims, Illinois
6/12/1984	1:26 PM	38.918	-87.464	3.4 mblg	113.33 / 182.39	5 km NNW of Oaktown, Indiana
6/29/1984	2:58 AM	37.7	-88.47	3.8 md	171.65 / 276.24	7 km SE of Harrisburg, Illinois
7/28/1984	6:39 PM	39.22	-87.07	4 md	114.71 / 184.61	6 km SE of Middlebury, Indiana
7/30/1984	2:33 AM	37.82	-90.92	3 md	197.36 / 317.62	14 km WNW of Caledonia, Missouri
8/29/1984	1:50 AM	39.11	-87.45	3.1 md	104.04 / 167.43	Illinois-Indiana border region
2/13/1985	5:22 AM	38.42	-87.5	3 md	140.44 / 226.02	7 km E of Patoka, Indiana
2/15/1985	10:56 AM	37.23	-89.33	3.3 md	204.71 / 329.45	5 km W of Tamms, Illinois
9/9/1985	5:06 PM	41.848	-88.014	3 mblg	123.31 / 198.45	3 km S of Lombard, Illinois
12/29/1985	3:56 AM	38.49	-89.02	3.2 md	116.47 / 187.44	2 km NE of Walnut Hill, Illinois
7/12/1986	3:19 AM	40.537	-84.371	4.5 mb	236.9 / 381.26	1 km ESE of Saint Marys, Ohio
8/26/1986	11:41 AM	38.32	-89.79	3.6 md	137.67 / 221.57	4 km NNE of Lenzburg, Illinois
10/29/1986	12:03 AM	38.44	-89.04	3 md	120 / 193.12	4 km S of Walnut Hill, Illinois
3/13/1987	1:37 PM	39.09	-89.41	3.2 md	80.72 / 129.91	1 km W of Coffeen, Illinois
4/26/1987	7:56 PM	38.54	-89.41	3.1 md	116.74 / 187.88	4 km E of Bartelso, Illinois
6/4/1987	12:19 PM	37.939	-85.8	3.1 md	224.36 / 361.08	9 km SW of Shepherdsville, Kentucky
6/10/1987	6:48 PM	38.71	-87.95	5.2 md	111.41 / 179.3	2 km ESE of Claremont, Illinois
7/7/1987	2:19 PM	36.941	-89.148	3.3 md	223.52 / 359.72	5 km WSW of Wickliffe, Kentucky
8/31/1987	12:12 PM	38.3	-89.68	3.3 md	136.89 / 220.3	5 km ESE of Darmstadt, Illinois
9/29/1987	7:04 PM	36.953	-89.159	4.3 md	222.74 / 358.47	6 km SSE of Cairo, Illinois
10/14/1987	10:49 AM	37.05	-88.78	3.8 md	215.37 / 346.6	5 km NW of Massac, Kentucky
11/17/1987	10:52 AM	38.72	-87.96	3.2 md	110.56 / 177.93	0 km E of Claremont, Illinois
1/5/1988	9:39 AM	38.72	-87.96	3.3 md	110.56 / 177.93	0 km E of Claremont, Illinois

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 3 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
2/27/1988	10:17 AM	36.68	-89.52	3.2 md	243.74 / 392.27	10 km N of New Madrid, Missouri
3/10/1988	4:24 PM	37.75	-88.83	3 md	167.08 / 268.89	3 km NW of Crab Orchard, Illinois
6/25/1988	10:02 AM	36.72	-89.5	3.1 md	240.85 / 387.61	8 km ESE of Matthews, Missouri
10/5/1988	7:38 PM	38.66	-88.02	3.3 md	113.06 / 181.95	2 km ENE of Calhoun, Illinois
1/24/1990	1:20 PM	38.14	-86.49	3.9 md	188.39 / 303.19	6 km WNW of Alton, Indiana
1/27/1990	9:05 AM	38.184	-86.43	3.8 md	188.31 / 303.06	6 km N of Alton, Indiana
3/2/1990	2:01 AM	38.851	-89.17	3.4 md	92.89 / 149.49	9 km NW of Vernon, Illinois
4/17/1990	5:27 AM	40.46	-84.852	3 mblg	211.23 / 339.94	8 km NW of Fort Recovery, Ohio
8/7/1990	12:05 AM	36.857	-89.237	3.1 md	229.71 / 369.68	5 km SSW of Wyatt, Missouri
9/26/1990	8:18 AM	37.152	-89.613	4.8 md	212.55 / 342.07	4 km SE of Chaffee, Missouri
10/24/1990	3:20 AM	38.346	-88.971	3.2 md	126.19 / 203.08	5 km ENE of Woodlawn, Illinois
12/17/1990	12:24 AM	40.068	-87.044	3.2 md	95.12 / 153.08	Illinois-Indiana border region
12/20/1990	9:04 AM	39.59	-86.63	3.7 md	123.86 / 199.34	5 km S of Stilesville, Indiana
1/23/1991	4:25 AM	37.94	-88.873	3.1 md	153.99 / 247.83	3 km WSW of Logan, Illinois
11/11/1991	4:20 AM	38.905	-87.71	3.8 md	106.07 / 170.7	3 km W of Flat Rock, Illinois
12/27/1992	5:12 AM	37.501	-89.616	3.2 md	189.03 / 304.22	2 km E of Pocahontas, Missouri
1/29/1993	8:56 AM	39.033	-89.03	3.2 mlg	79.28 / 127.59	7 km WNW of Brownstown, Illinois
2/6/1993	9:09 PM	36.664	-89.733	3.3 mlg	246.86 / 397.29	6 km NNW of Catron, Missouri
3/2/1993	7:29 PM	36.673	-89.494	3 mlg	244.01 / 392.69	10 km NNE of New Madrid, Missouri
3/31/1993	3:23 PM	36.799	-89.423	3.1 mlg	234.85 / 377.96	3 km WNW of East Prairie, Missouri
8/27/1993	7:08 PM	38.091	-90.437	3.3 mlg	167.43 / 269.45	5 km SSE of Olympian Village, Missouri
2/5/1994	9:55 AM	37.368	-89.188	4.2 mlg	194.37 / 312.81	2 km WNW of Dongola, Illinois
2/28/1994	1:29 PM	37.833	-89.374	3 mlg	163.96 / 263.86	5 km NW of Harrison, Illinois
4/6/1994	12:38 PM	38.156	-89.214	3.2 mlg	140.57 / 226.23	2 km NE of Tamaroa, Illinois
9/26/1994	9:23 AM	36.96	-88.92	3.4 mlg	221.61 / 356.64	4 km ENE of Blandville, Kentucky
12/16/1996	8:58 PM	39.5	-87.4	3.1 mblg	89.3 / 143.71	3 km NNE of Terre Haute, Indiana

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 4 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
4/8/1998	1:16 PM	36.9621667	-88.9741667	3.2 mlg	221.54 / 356.53	2 km NNW of Blandville, Kentucky
9/2/1999	11:17 AM	41.721	-89.433	3.5 mblg	111.35 / 179.2	8 km W of Amboy, Illinois
4/14/2000	10:54 PM	39.76	-86.75	3.6 mlg	114.25 / 183.88	4 km NW of Heritage Lake, Indiana
12/7/2000	9:08 AM	37.9711667	-87.6365	3.9 md	164.91 / 265.4	7 km W of Evansville, Indiana
3/12/2002	3:30 AM	37.2496667	-89.9596667	3.1 md	210.59 / 338.91	6 km S of Marble Hill, Missouri
6/18/2002	12:37 PM	38.0001667	-87.7563333	4.6 mw	160.63 / 258.51	6 km SW of Parkers Settlement, Indiana
5/2/2003	3:10 AM	37.9655	-88.6633333	3.2 md	152.49 / 245.42	10 km ENE of Thompsonville, Illinois
6/6/2003	7:29 AM	36.8788333	-88.9958333	4 mw	227.33 / 365.85	-
8/26/2003	9:26 PM	37.1055	-88.6828333	3.1 mlg	211.68 / 340.66	5 km WSW of Brookport, Illinois
12/29/2003	4:02 AM	38.1238333	-90.1678333	3 mw	158.43 / 254.97	eastern Missouri
6/15/2004	3:34 AM	36.7258333	-89.6833333	3.5 mw	242.15 / 389.7	3 km S of Canalou, Missouri
6/28/2004	1:10 AM	41.46	-88.9	4.2 mwr	88.91 / 143.09	12 km NW of Dayton, Illinois
7/16/2004	10:25 PM	36.8648333	-89.1753333	3.5 mw	228.88 / 368.34	6 km SE of Wyatt, Missouri
9/12/2004	8:05 AM	39.6043333	-85.6615	3.8 mw	173.1 / 278.58	4 km NW of Manilla, Indiana
6/20/2005	7:21 AM	36.9225	-89.0041667	3.6 mw	224.34 / 361.03	4 km WSW of Blandville, Kentucky
6/27/2005	10:46 AM	37.6341667	-89.4193333	3 mlg	177.89 / 286.29	6 km E of Grand Tower, Illinois
7/31/2005	2:07 AM	38.718	-92.725	3.3 mblg	231.2 / 372.07	Missouri
1/2/2006	4:48 PM	37.8415	-88.4171667	3.6 mlg	162.32 / 261.24	3 km NNE of Eldorado, Illinois
3/1/2006	12:42 PM	37.4976667	-88.982	3 mlg	184.66 / 297.17	2 km N of Buncombe, Illinois
4/18/2008	4:36 AM	38.4515	-87.8861667	5.2 mw	129.12 / 207.79	7 km NNE of Bellmont, Illinois
4/18/2008	10:14 AM	38.4585	-87.8691667	4.7 mw	129.03 / 207.66	9 km NNE of Bellmont, Illinois
4/21/2008	12:38 AM	38.4475	-87.8755	4 mw	129.6 / 208.56	7 km NNE of Bellmont, Illinois
4/25/2008	12:31 PM	38.4505	-87.873	3.7 mw	129.46 / 208.34	8 km NNE of Bellmont, Illinois
5/1/2008	12:30 AM	38.4526667	-87.8591667	3.3 mlg	129.62 / 208.6	8 km NNE of Bellmont, Illinois
6/5/2008	2:13 AM	38.4538333	-87.8436667	3.4 mw	129.88 / 209.02	8 km WNW of Mount Carmel, Illinois
7/18/2008	9:58 PM	38.442	-87.8943333	3.1 mlg	129.55 / 208.49	6 km NNE of Bellmont, Illinois

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 5 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
2/10/2010	4:59 AM	41.969	-88.498	3.8 mwr	125.21 / 201.5	2 km NW of Lily Lake, Illinois
3/2/2010	2:37 PM	36.788	-89.3561667	3.7 mlg	235.14 / 378.42	2 km ENE of East Prairie, Missouri
12/30/2010	7:55 AM	40.43	-85.914	3.8 mwr	155.28 / 249.9	6 km SE of Greentown, Indiana
5/3/2011	10:02 PM	36.954	-89.121	3.1 mblg	222.52 / 358.11	3 km WSW of Wickliffe, Kentucky
6/7/2011	3:10 AM	38.0773333	-90.902	3.9 mw	182.32 / 293.42	18 km NNW of Potosi, Missouri
1/26/2012	5:35 PM	41.576	-85.49	3 mblg	200.12 / 322.06	5 km NE of Topeka, Indiana
2/21/2012	4:58 AM	36.8733333	-89.4226667	3.9 mw	229.77 / 369.78	4 km SSE of Bertrand, Missouri
5/10/2012	5:54 PM	38.8066667	-87.4606667	3.1 mlg	119.44 / 192.22	0 km NW of Emison, Indiana
11/20/2012	6:28 PM	38.4548333	-87.9018333	3.6 mlg	128.58 / 206.92	7 km N of Bellmont, Illinois
11/4/2013	1:35 PM	41.7999	-87.8247	3.2 mb_lg	124.09 / 199.7	1 km SSW of Lyons, Illinois
5/2/2015	11:23 AM	42.2357	-85.4285	4.2 mwr	227.49 / 366.11	5 km S of Galesburg, Michigan
5/30/2015	7:41 PM	38.462	-88.3561667	3.4 mlg	120.73 / 194.29	4 km ENE of Geff, Illinois
6/30/2015	10:42 AM	42.1464	-85.0459	3.3 mb_lg	239.91 / 386.11	5 km NNE of Burlington, Michigan
5/1/2016	1:12 AM	37.2136667	-88.9876667	3.5 mlg	204.24 / 328.69	5 km SE of New Grand Chain, Illinois
3/15/2017	11:51 AM	36.8816667	-89.1225	3.59 mw	227.5 / 366.13	9 km ESE of Wyatt, Missouri
3/19/2017	9:25 AM	36.8795	-89.1278333	3.16 md	227.67 / 366.4	9 km ESE of Wyatt, Missouri
5/16/2017	5:21 AM	36.873	-89.1216667	3.26 mw	228.1 / 367.08	9 km ESE of Wyatt, Missouri
7/1/2017	1:07 PM	38.85	-89.2275	3.12 mw	93.6 / 150.63	9 km SSE of Mulberry Grove, Illinois
9/9/2017	11:15 PM	38.425	-87.913	3.06 md	130.25 / 209.62	4 km N of Bellmont, Illinois
9/19/2017	6:47 AM	38.4238333	-87.9098333	3.8 mw	130.39 / 209.84	4 km N of Bellmont, Illinois
9/27/2019	11:42 PM	36.7713333	-89.2541667	3.03 md	235.68 / 379.29	6 km NE of Pinhook, Missouri
6/17/2021	2:18 PM	39.8305	-87.2866667	3.82 mw	85.46 / 137.53	Illinois-Indiana border region

Table 3.5-2 Historical Seismic Events of Magnitude 3.0 or Greater within 248.5 miles (400 kilometers) of CPS Center Point, 1970-2023[(a)] (Sheet 6 of 6)

Earthquake Date	Local Time	Latitude	Longitude	Magnitude	Distance from CPS (miles/km)	Approximate Location
11/18/2021	9:53 PM	36.9076667	-90.543	4 mw	243.51 / 391.89	7 km S of Williamsville, Missouri
11/5/2022	1:44 PM	37.0878333	-91.0195	3.16 md	243.47 / 391.83	10 km N of Van Buren, Missouri
5/30/2023	9:45 PM	37.5391667	-87.3303333	3.03 md	198.88 / 320.07	6 km W of Calhoun, Kentucky

a. All seismic events within 248.5 miles (400 km) with a Richter magnitude of greater than 3.0 between January 1, 1970, and June 5, 2023.
b. Seismic event caused by explosion.
mb = Short-period body wave
mblg, mb_lg, mlg, lg = Short-period surface wave
md = Duration
ml = Local
mw = Moment W-phase
mwr = Regional
(USGS 2022a; USGS 2023a)

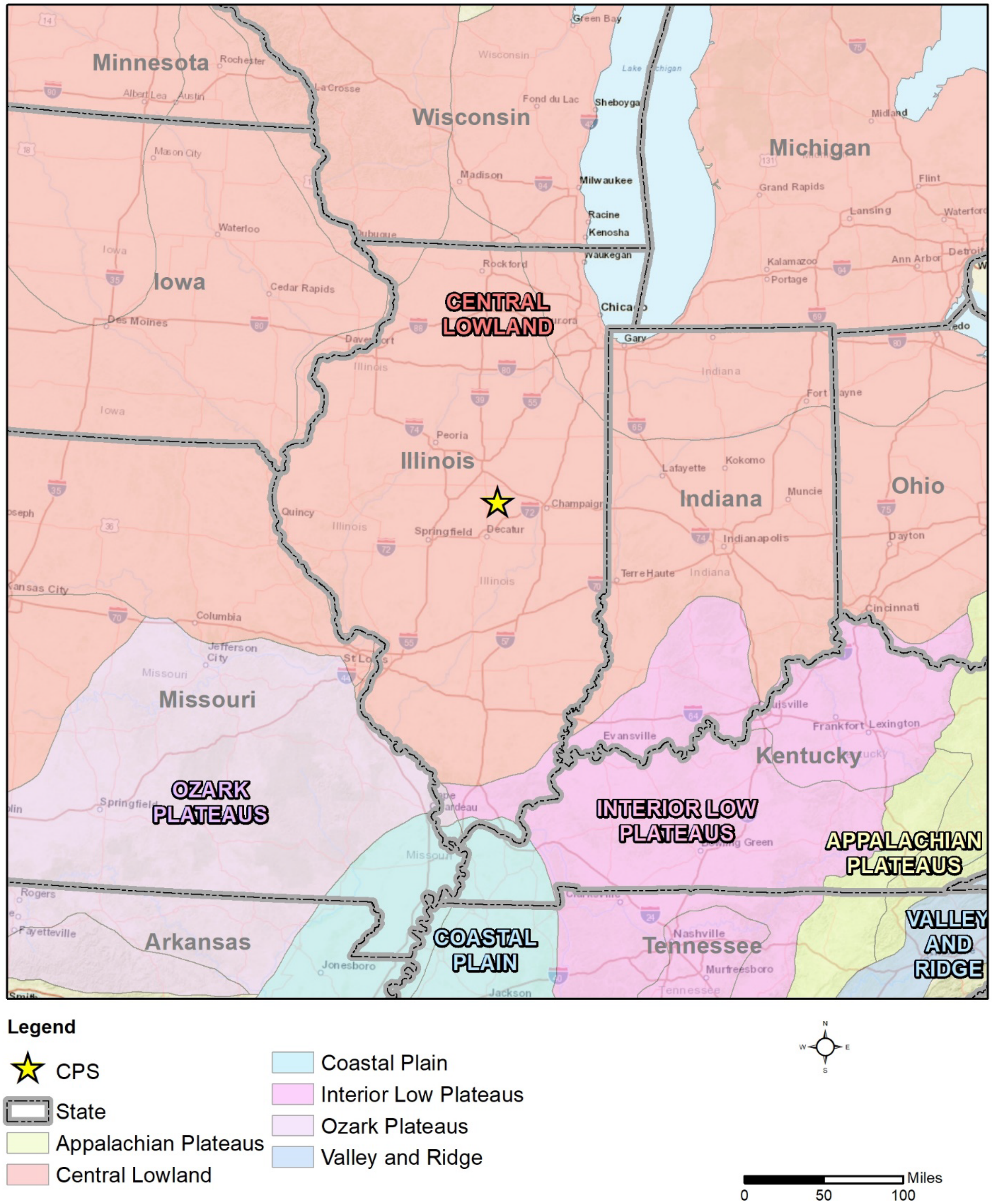


Figure 3.5-1 Physiographic Provinces Associated with CPS

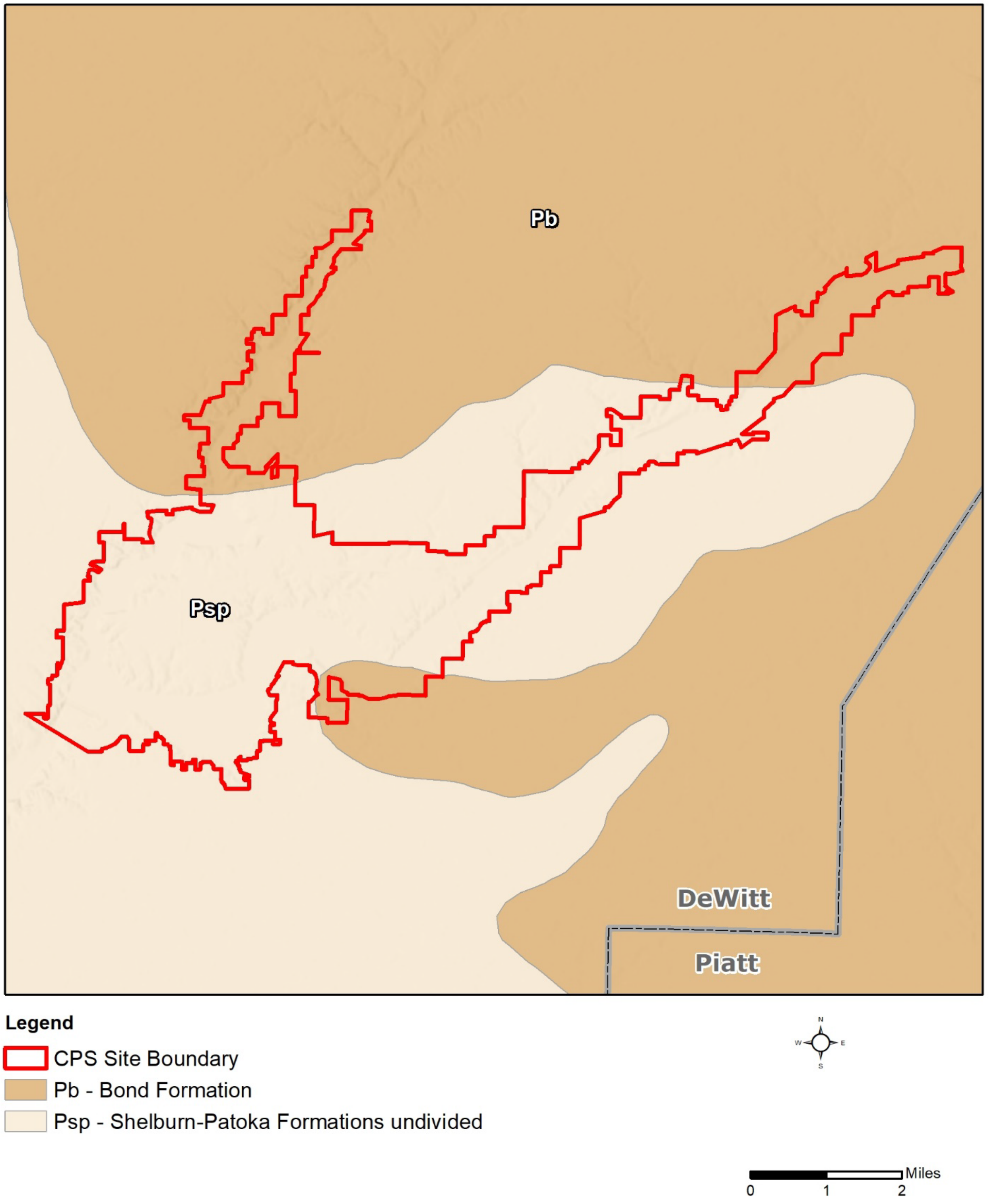


Figure 3.5-2 Bedrock Geology Map, CPS Property

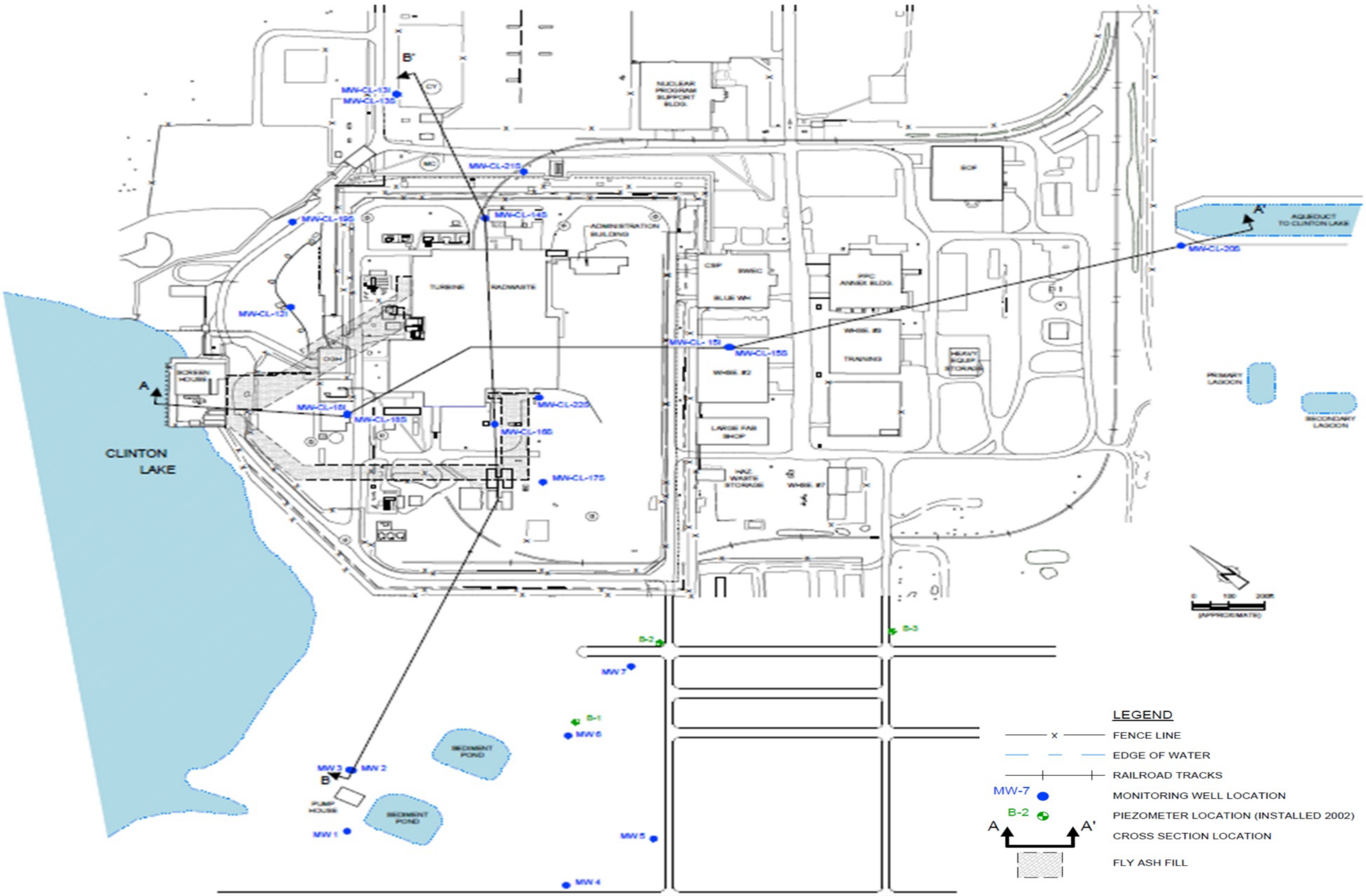


Figure 3.5-3a Hydrological Cross-Section Locations on CPS

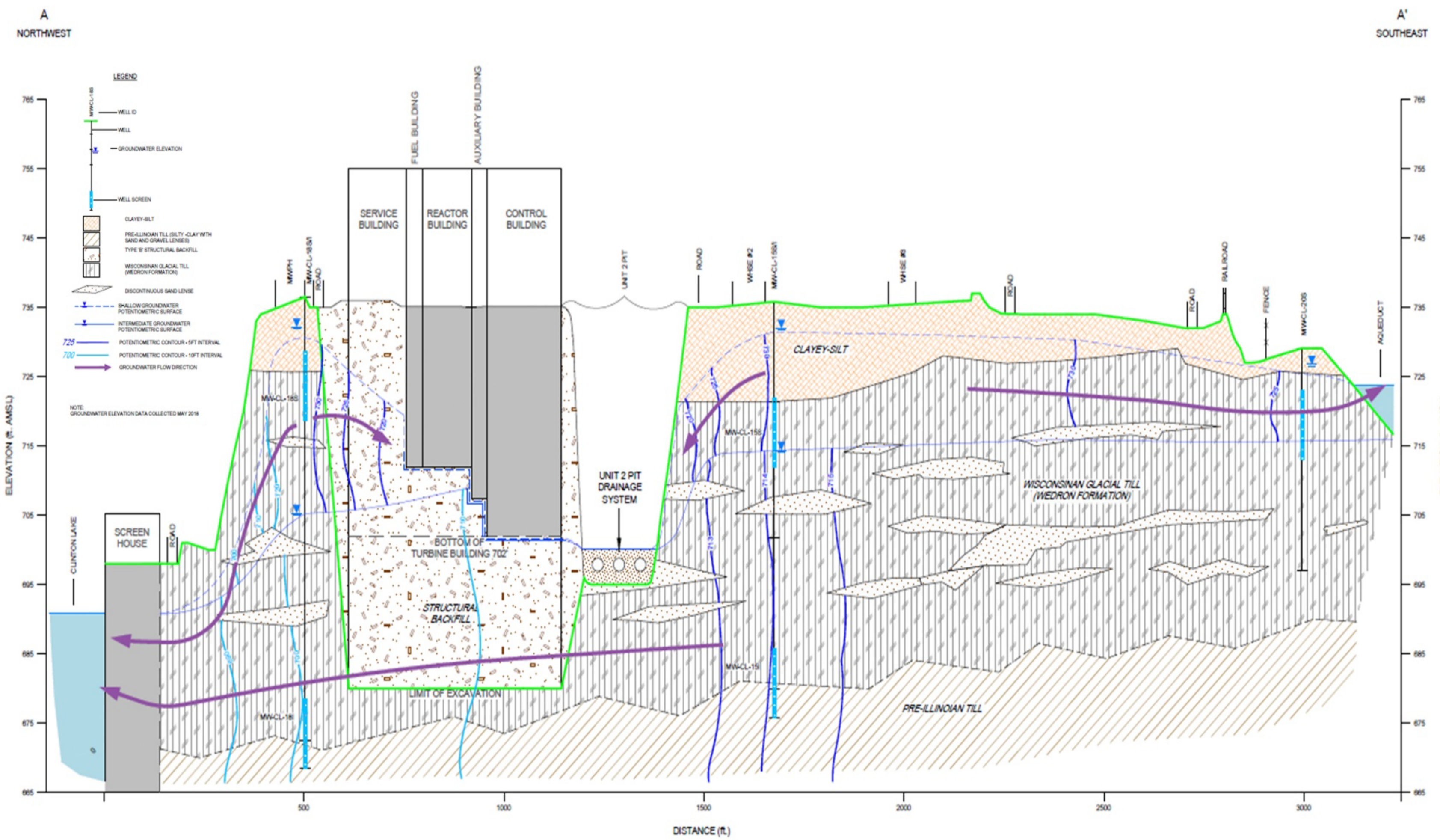


Figure 3.5-3b Cross-Section A-A'

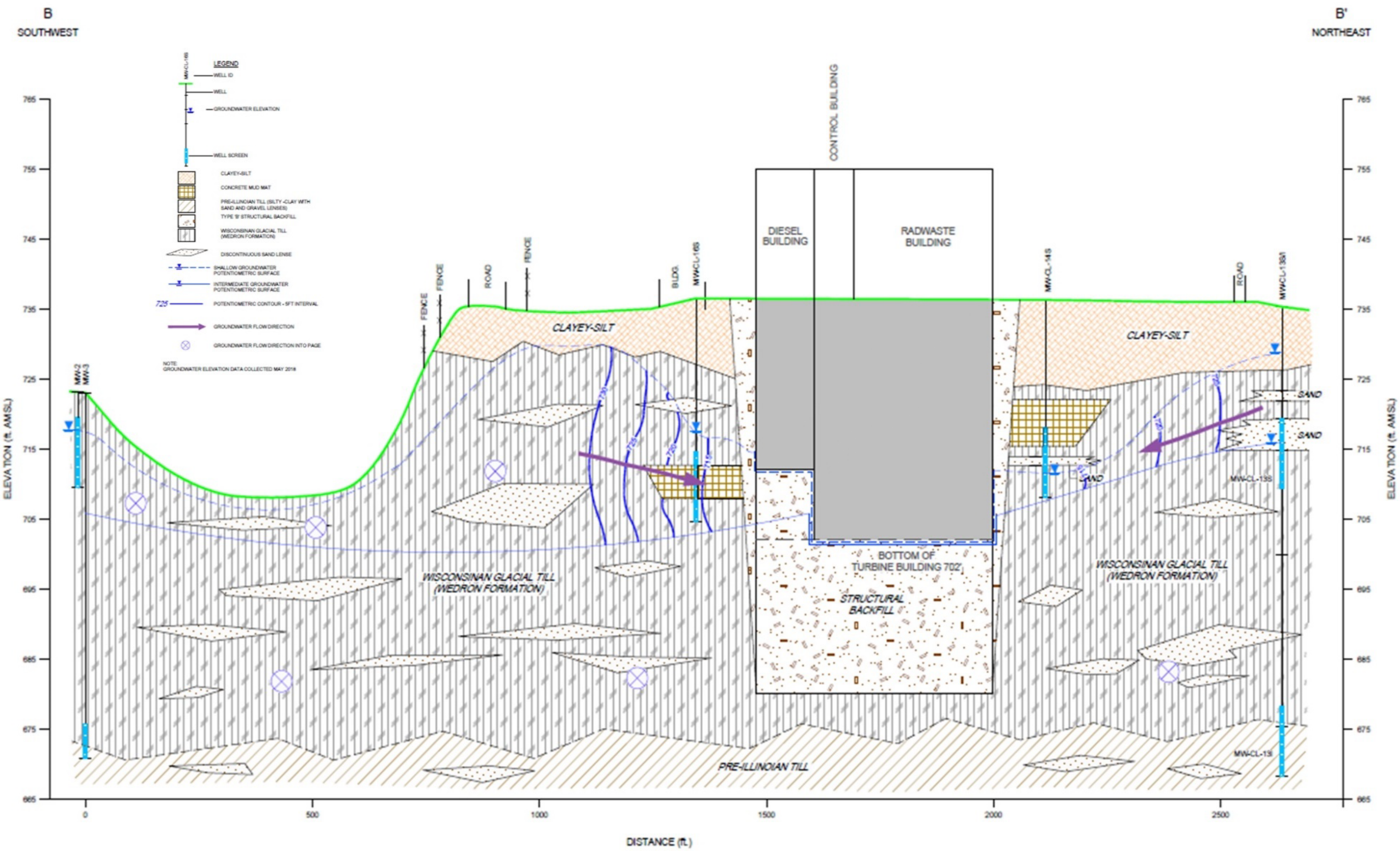


Figure 3.5-3c Cross-Section B-B'

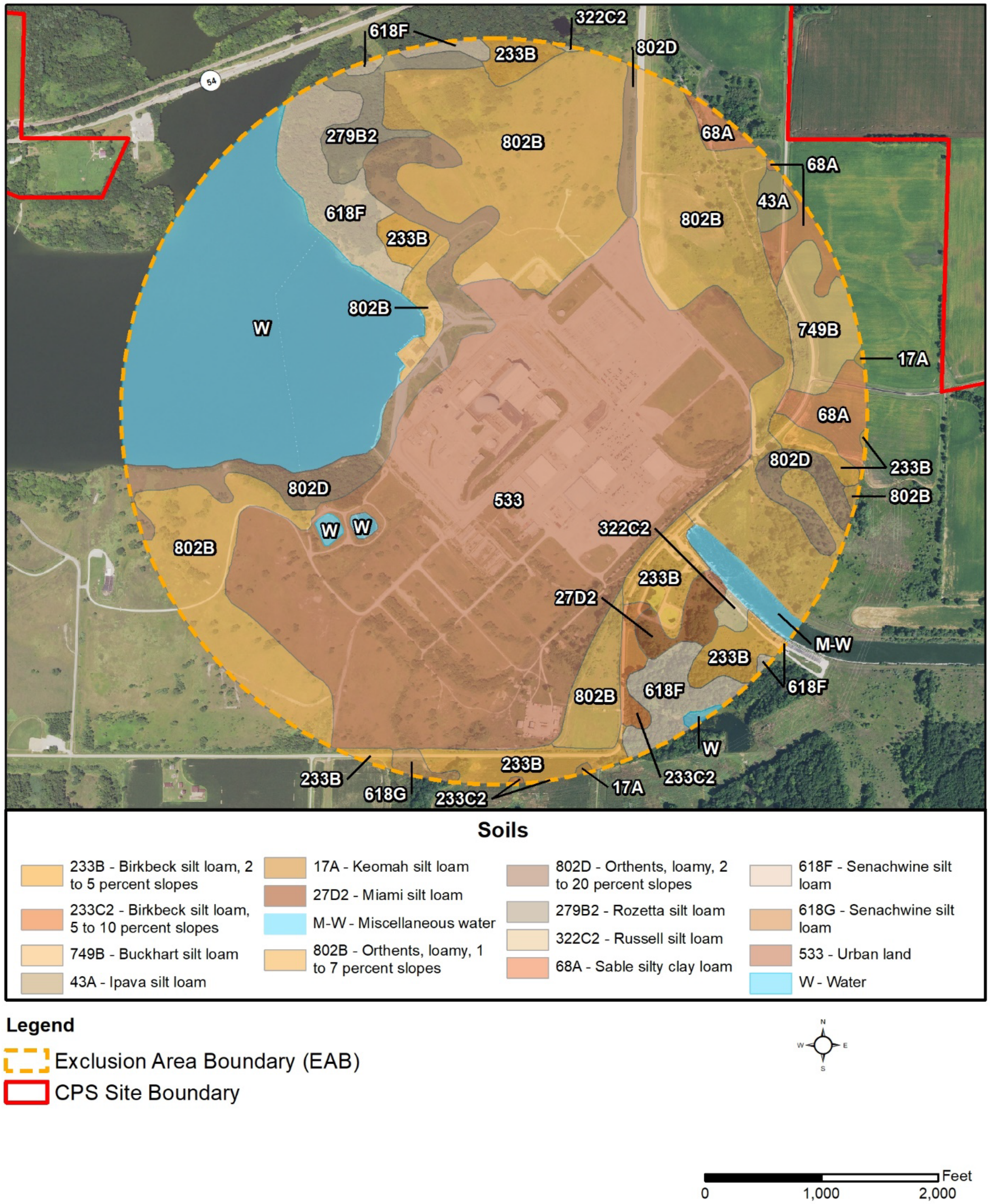


Figure 3.5-4 Distribution of Soil Units, CPS Property

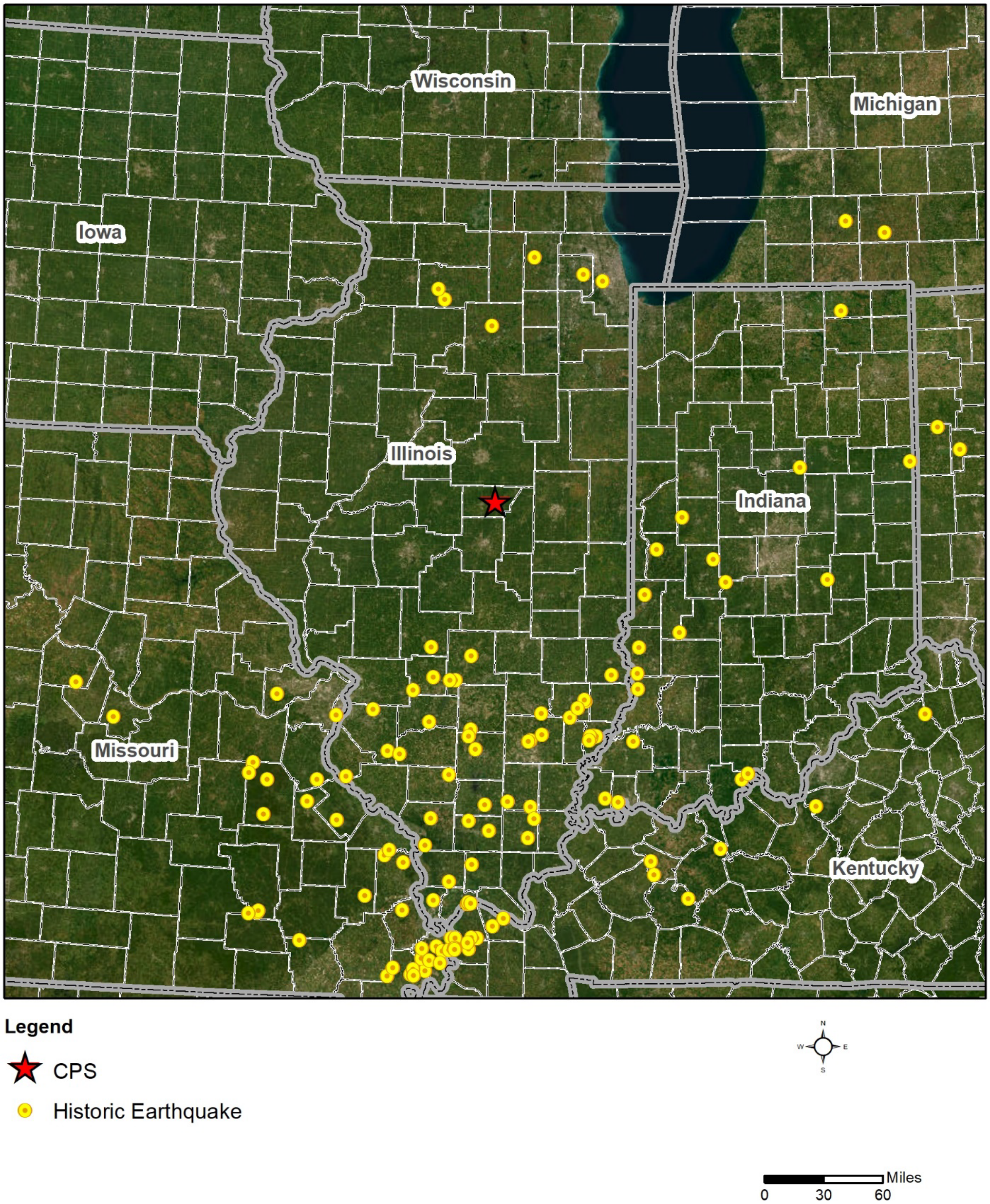


Figure 3.5-5 Historic Seismic Events, 1970–May 2023

3.6 Water Resources

3.6.1 Surface Water Resources

CPS is in DeWitt County, Illinois, approximately 6 miles east of the city of Clinton and along the shore of Clinton Lake (EGC 2006). CPS consists of approximately 13,626 acres, including the manmade Clinton Lake. CPS is located on the peninsula between the North Fork and Salt Creek arms of Clinton Lake (NRC 2006). The hydrologic features near CPS are shown in Figure 3.6-1.

Clinton Lake is a 4,895-acre freshwater lake created by the construction of an earthen dam 1,200 feet downstream of the confluence of Salt Creek and the North Fork of Salt Creek. CPS is approximately 3.5 miles northeast of the dam at an approximate grade elevation of 736 feet. The average depth of Clinton Lake is 15.2 feet with a maximum depth of 45 feet. Clinton Lake has a retention time of approximately 146 days. (IEPA 2021a)

CPS Unit 1 withdraws cooling water from the North Fork arm and returns it to the Salt Creek arm. This results in a circulation between the two locations whenever the inflow into the North Fork arm is less than the intake demands for the CPS unit's once-through cooling system. CPS is at a station grade elevation of 736 feet and station floor elevation of 737 feet. Water released from Clinton Lake Dam flows down Salt Creek until it joins the Sangamon River. The IEPA requires a minimum release of 5 cubic feet per second (cfs) from the Clinton Lake Dam, pursuant to the NPDES permit. (NRC 2006)

A concrete service spillway with an ogee-type crest is provided on the west abutment of the dam to pass floods. An auxiliary spillway is provided on the east abutment to pass floods more severe than an occurrence of once per 100 years, including the probable maximum flood (PMF). A lake outlet structure is located near the west abutment to provide a minimum downstream release of 5 cfs. The UHS for the emergency core cooling system is provided within the cooling lake with a submerged dam constructed across the North Fork, which includes an approach channel leading into the circulating water screen house. (EGC 2020a) CPS maintains a secure storage impoundment of cooling water that is available in the unlikely event of failure of the main dam and loss of the cooling lake. The UHS within Clinton Lake was constructed to supply cooling water for the safe shutdown equipment. (EGC 2006)

The UHS submerged dam is located 1 mile west of the screen house. The area of the UHS at the design water surface elevation of 675 feet is 158 acres with a total volume of 1,067 acre-feet. The top of the submerged dam is at elevation 675 feet with a width of 30 feet and a length of 2,350 feet. The dam consists of homogeneous compacted backfill materials. The excavation for the dam foundation is extended to the Illinoian till. (EGC 2020a)

The station circulating water screen house is located on the North Fork arm of the lake with the circulating water discharging into the Salt Creek arm through a discharge flume. (EGC 2020a) Cooling water for CPS is withdrawn from the North Fork arm of Salt Creek via three pumps. The circulating water system is routed through the circulation water lines to deliver water to the main condenser in sufficient quantities to condense the turbine-relayed exhaust steam. After the cooling water is used to condense steam, it is piped to the Seal Well and subsequently to the discharge flume. The Seal Well is a rectangular concrete structure composed of two chambers that are located at the northeast side of the turbine building. The purpose of the Seal Well is to retain the required amount of water to keep the circulating water piping full in the event all circulating water pumps trip. Condenser effluent flows into the upstream and then downstream chamber of the Seal Well. A drain valve is installed between the two chambers to allow the upstream chamber to drain to the downstream chamber.

The discharge flume is an unlined, earthen, manmade canal that routes the cooling water along a 3.4-mile route, after which it discharges into the Salt Creek arm of Clinton Lake The discharge flume is located east of the station area and runs due east toward the lake. A 6-inch-thick crushed stone layer is provided on the side slopes of the flume for protection against erosion due to wind wave action in the flume. Riprap is provided on the lake side of the embankment fills for protection against erosion due to wind wave action in the lake. Drop structures of the baffled apron type are provided at two locations along the discharge flume to adapt the flume design to ground topography and to prevent scouring in the flume during station operations at design drought conditions in the lake. The two drop structures are 70 feet wide. The first one is designed for a drop of 18 feet and the second is designed for a drop of 26 feet. Provisions against erosion are provided at the end of both drop structures. Drainage crossings under the flume are provided at two locations to drain the areas north of the flume. The drainage structures consist of corrugated metal pipes designed for 100-year flood conditions. Anti-seep collars and erosion protection are provided on the structures. (EGC 2020a) CPS also discharges water to Clinton Lake via several outfalls under the NPDES permit, which is described further in Section 3.6.1.2.1.

The sediment ponds collect wastewater from various station systems. The sediment pond filter house system collects and treats non-radioactive wastewater (industrial wastewater) generated by CPS. The sediment pond filter house system removes suspended solids and allows for manual potential hydrogen (pH) adjustment, if needed, prior to discharging water to Clinton Lake. Representative samples are analyzed during the release process to ensure wastewater returning to the lake meets NPDES permit requirements. The Sediment Ponds receive water from backwash from upflow and sand filters, surveillance operation and equipment maintenance wastewater, reverse osmosis unit reject waste and cleaning chemicals, off-specification water from mixed bed polishers, auxiliary boiler blowdown, standby liquid control pump, laboratory chemicals, and ventilation and service air compressor condensate. The Sediment Ponds are two earthen enclosures that make up the three ponds: lower (1,900,000 gallons), middle (1,590,000 gallons) and upper (2,500,000 gallons). The upper and middle ponds are essentially the same pond separated by a concrete barrier. The lower pond is cross tied to the upper/middle ponds. CPS uses ultrasonic algae control devices, parallel sand filters in the lower pond, and chemical treatment (Cutrine algaecide and sulfuric acid) to inhibit algae growth and clarify the water contained within the sediment ponds to ensure NPDES permit discharge requirements for pH and total suspended solids (TSS). (IEPA 2021a) Surface water discharges through NPDES-permitted outfalls are discussed further in Section 3.6.1.2.1.

Upstream from Clinton Lake Dam, the Salt Creek and North Fork arms of Clinton Lake extend 14 miles and 8 miles, respectively (EGC 2020a). Clinton Lake is in the upper reaches of Salt Creek, 28 miles from its source. The drainage basin above the dam site has a fan shape with an area of 296 square miles. The highest elevation of the drainage basin is 910 feet and the lowest elevation at the dam site is 650 feet. The drainage basin consists of farmlands and pasture lands with trees along the floodplains and adjacent areas. (EGC 2020a)

There are two dams upstream of Clinton Lake on the North Fork of Salt Creek: Moraine View Dam on Dawson Lake and Vance Lake Dam on Clyde Vance Lake. The maximum combined storage capacity of these two reservoirs is 4,446 acre-feet. This volume is small compared to the volume of Clinton Lake, 74,200 acre-feet at normal water level of 690 feet above MSL. (EGC 2020a)

Salt Creek flows through rolling country for 40 miles with a fall of 300 feet. Channel slope varies from over 10 feet per mile in the upper reaches to less than 3 feet per mile near the Town of Rowell. The drainage area of Salt Creek to the Clinton Lake Dam is 296 square miles. The main tributaries of Salt Creek include North Fork of Salt Creek, Lake Fork, Deer Creek, Kickapoo Creek, Tenmile Creek, and Sugar Creek. No existing reservoirs or dams upstream or downstream from Clinton Lake could affect the availability of water to Clinton Lake. (EGC 2006)

Salt Creek is in the central region of Illinois and within the Sangamon River basin, which drains into the Illinois River. Salt Creek is the principal tributary of the Sangamon River. It rises 15 miles east of Bloomington in McLean County and flows in a southwesterly direction into DeWitt County. Thereafter, it pursues a westerly course to join the Sangamon River, 8 miles east of Oakford in Menard County. The total length of Salt Creek is 92 miles, and the drainage area is 1,860 square miles. (EGC 2020a)

The Sangamon River Basin drains into the Illinois River about 10 miles upstream from Beardstown, Illinois, about 75 miles west of CPS. The Sangamon River has a length of 200 miles and a drainage area of 5,400 square miles. Salt Creek is the principal tributary of the Sangamon River. Salt Creek's headwaters are 15 miles east of Bloomington in McClean County and flows in a southwesterly direction into DeWitt County. Thereafter, it pursues a westerly course through Logan County and into Mason and Menard Counties to join the Sangamon River, eight miles east of Oakford. The maximum relief in the basin between the mouth and the high point on the drainage divide, near LeRoy, is 440 feet. (EGC 2006)

3.6.1.1 Potential for Flooding

Clinton Lake has a normal pool elevation of 690 feet (EGC 2020a). The PMF elevation is 708.8 feet and the maximum wave runup elevation is 711.8 feet (EGC 2020a). CPS is at grade elevation 736 feet, which would not be affected by floods in the lake (EGC 2006). The estimated maximum water surface elevation around the station is lower than the station floor elevation of

737 feet (EGC 2020a). The circulating water screen house is designed to withstand the effects of a PMF (EGC 2020a).

USGS gauging station 05578300 is in Clinton Lake near the Clinton Lake Dam. Gauging data are available since August 2008. Daily average gauge heights in Clinton Lake have been consistently below the PMF elevation since 2008. (USGS 2023a)

Clinton Lake Dam is a homogeneous earth-fill dam with a maximum height of 65 feet above the creek bed and a length of 3,040 feet. The top of the dam is at elevation 711.8 feet. A freeboard of 3 feet is provided to prevent overtopping of the dam by the PMF and significant wave runup. The time duration over which overtopping by wave action would occur is 2.5 hours (711.8 feet elevation, as stated above). Any overtopping would be in the form of spray because the wave runs up the upstream slope and the water would be lifted into the air, creating a fine spray. Since most of the runup would be contained by the dam, only about 0.15 feet of the runup would be overtopping in the form of spray. The downstream slope is protected with grass against gully erosion, which protects it from significant damage from overtopping. (EGC 2020a) CPS is required by 17 IAC 3702.40(b)(4) to maintain an Operations Plan, which includes an emergency warning plan that outlines procedures to be followed during major storm events or other emergency situations. The warning plan includes monitoring dam conditions, warning state and local officials of problems requiring immediate repair, indicating how needed repairs would be accomplished, and indicating if any downstream evacuation may be necessary.

There are no existing dams upstream or downstream of the cooling lake that can affect the station safety-related facilities or the availability of the station cooling water supply. Furthermore, a postulated failure of the cooling lake dam would not result in the loss of water from the UHS. (EGC 2020a)

Clinton Lake significantly attenuates flood flows in Salt Creek. A USGS gauging station on Salt Creek is located near Rowell (05578500), 12 miles downstream from the dam site, with a drainage area of 335 square miles (EGC 2006). The station has records from October 1942 to 1976 (EGC 2020a). There are no discharges over 10,000 cfs recorded at the Rowell gauging station after construction of the Clinton Lake Dam. As a result of the dam, the 10-year recurrence interval flood flow at the Rowell gaging station is reduced from 11,400 cfs to 6,000 cfs. The 100-year recurrence flood flow is reduced from 29,900 cfs to 9,800 cfs. (EGC 2006)

Prior to dam construction, the average discharge of Salt Creek at the Rowell gauging station 1942-1976 was 241 cfs. The maximum flow of record was 24,500 cfs (May 16, 1968). (EGC 2020a) A flood flow of 10,000 cfs had a return period of about 8 years. The discharge obtained for a flood of 100-year frequency was 29,900 cfs. The mean annual flood was 4,300 cfs at a stage of about 20 feet. Ice jam effects were recorded at the gauging station for floods observed during winter months, but the stages and discharges did not exceed the maximum observed values for the period of record. (EGC 2020a) To date, flood flows at the Rowell gauging station have been lower than preconstruction flood flows (EGC 2006; USGS 2023c).

A service spillway is provided to pass a design flood of 100-year frequency with a flood water surface elevation of 697 feet in Clinton Lake. It is located on the west abutment of the dam, mainly due to favorable soil conditions. The service spillway is an uncontrolled concrete ogee type, semicircular in plan, with a crest length of 690 feet. The height of the concrete ogee is 10 feet. From the ogee section, the water will discharge through an 80-foot-wide concrete chute and into a stilling basin. A discharge channel is excavated to convey the water from the stilling basin to the main channel of Salt Creek. The total length of the spillway from the face of the ogee section to the end of the stilling basin is 603 feet. (EGC 2020a)

The peak discharge through the spillway for the 100-year flood is 11,450 cfs and the water surface elevation downstream of the ogee is 687.6 feet. The peak discharge through the spillway for the PMF is 33,200 cfs with a flood water surface elevation of 708.8 feet at the crest. The water surface elevation downstream of the ogee is 696.5 feet. (EGC 2020a)

The auxiliary (emergency) spillway is located east of the dam. It is designed to pass floods more severe than the 100-year flood up to and including the PMF. The spillway provides protection to the dam against overtopping. The spillway is an open-cut type with a crest length of 1,200 feet and a crest elevation of 700 feet. The flood water is discharged back into the main channel of Salt Creek between the dam and the Illinois State Route 10 bridge. (EGC 2020a)

The peak discharge through the auxiliary spillway during the PMF is 102,800 cfs with a corresponding water level in the lake of elevation 708.8 feet. The approach channel is excavated to elevations varying from 690 to 695 feet. The length of the approach channel is 1,510 feet along the centerline of the spillway. The bottom of the discharge channel is elevation 695 feet. The length of the discharge channel is 2,120 feet along the centerline of the spillway. Erosion control measures on the auxiliary spillway are provided for the safety of the dam and the spillway structure during extreme flood conditions. (EGC 2020a)

As stated in Section 3.6.1, there are two dams upstream of Clinton Lake: Moraine View Dam on Dawson Lake and Vance Lake Dam on Clyde Vance Lake. The effect of a flood wave resulting from a breach of these two dams coincident with a PMF is not significant. The maximum combined storage capacity of these two reservoirs is 4,446 acre-feet. This volume is small compared to the volume of Clinton Lake, which is 74,200 acre-feet at normal water level of 690 feet MSL. The effect of a flood wave resulting from a breach of these two dams coincident with a PMF event in the Clinton Lake watershed is not significant. (EGC 2020a)

Massive landslide from the valley walls into the cooling lake caused by a seismic disturbance is not possible because of lack of susceptible topographic and geological features. Thick glacial till available in the site precludes the possibility of massive landslides that can produce flood waves greater in magnitude than the PMF conditions and coincident wind wave effects. (EGC 2020a)

Based on Federal Emergency Management Agency (FEMA) data, the CPS active station area is in an area of minimal flood hazard. Clinton Lake and the North Fork and Salt Creek arms are in Zone AE, which is an area of inundation by the one-percent-annual-chance flood. (Figure 3.6-2)

3.6.1.2 Surface Water Discharges

3.6.1.2.1 NPDES-Permitted Outfalls

Chemical additives approved by the IEPA are used to control pH, scale, and corrosion in the circulating water system, and to control biofouling of station equipment. Chemicals used in raw water treatment, component cooling system treatment, and sewage treatment are listed in the 2016 NPDES permit application. Process wastewaters are monitored and discharged to Clinton Lake via NPDES outfalls in accordance with the CPS NPDES Permit No. IL0036919. The current NPDES permit authorizes discharges from 11 outfalls: two internal (A02 and B02) and nine external (002, 003, 004, 005, 006, 007, 008, 011, and 015). (IEPA 2021b) External outfall locations are depicted in Figure 3.6-3, and the effluent limits for the internal and external outfalls are listed in Table 3.6-2.

The following outfalls discharge to the west arm of Clinton Lake:

- Outfall 003 is located north of the sediment ponds and consists of water treatment wastes. (IEPA 2021b) As described in Section 3.6.1, CPS uses a sand filtration system and ultrasonic algae control devices to inhibit algae growth and clarify the water contained within the sediment ponds to ensure NPDES permit discharge requirements are met for pH and TSS.
- Outfall 004 is located north of the turbine building and northeast of the screen house. Discharges are intermittent and primarily consists of water from the transformer area oil/water separator. (IEPA 2021b)
- Outfall 005 is located southeast of the dry cask storage. Discharges are intermittent and primarily consist of water from the diesel generator area oil/water separator. (IEPA 2021b)
- Outfall 006 is located northeast of the screen house. Discharges primarily consist of screen house intake discharges, which include screen house intake screen backwash, warming line waters, service water backflow, and non-chlorinated sample water. (IEPA 2021b)
- Outfall 007 is located south of the makeup water pump house (IEPA 2021a). Discharges are from the safe shutdown service water System, which consist of equipment cooling water, diesel generator cooling water, and water from residual heat removal heat exchangers. (IEPA 2021b)
- Outfall 008 is located north of the switchyard (IEPA 2021a). Discharges occur only during refueling and other forced outages. Discharges consist of unheated pump-bearing cooling waters. (IEPA 2021b)

The following outfalls discharge to the east arm of Clinton Lake:

- Outfall 011 discharges stormwater from approximately 136 acres inside the approximately 150-acre station facility (within the fence line), including sediment pond runoff, the southeastern station areas, and an area of helper cooling towers installed along the south bank of the discharge flume. Within the Outfall 011 drainage area, most of the material storage and industrial activities occur inside buildings and are not exposed to stormwater. There are no monitoring requirements for this outfall, but the outfall is visually inspected per the SWPPP. (IEPA 2021b) The outfall is located southeast of the station area and south of the discharge flume. (IEPA 2021a)
- Internal Outfall A02 is primarily for sewage treatment plant effluent (IEPA 2021b), which is described in Section 3.6.1.2.3.
- Internal Outfall B02 is for radwaste treatment system effluent (IEPA 2021b).
- Outfall 002 is the discharge flume. Discharges consist of main condenser cooling water, station service water, makeup water treatment system water, screen house sump discharges, and discharges from internal Outfalls A02 and B02. (IEPA 2021b) This outfall discharges to the east arm of Clinton Lake east of the station. The NPDES permit compliance point is at the second drop structure of the discharge flume. (IEPA 2021a)
- Outfall 015 consists of intermittent discharges from UHS dredge pond discharge (IEPA 2021a). The dredge pond is discussed further in Section 3.6.1.2.4. This outfall is located southwest of the station area (IEPA 2021a).

3.6.1.2.2 Stormwater Runoff

Liquid effluents from the station are discharged into Clinton Lake, which joins the Sangamon River approximately 56 miles downstream (EGC 2020a). The topography of CPS is generally flat but slopes steeply from the western end of the station to the edge of Clinton Lake. Surface water drains through the stormwater system and manmade ditches and generally flows to the south.

CPS is provided with a drainage system that drains into the east and west arms of Clinton Lake. The area traversed by the discharge flume has drainage crossings into the east arm of the lake. The areas surrounding the station are graded to direct surface runoff away from the station. Roof drains are connected to the underground storm sewer system with piping. The station side drainage system is designed to pass the 10-year storm without any flooding of the adjacent area. During a 100-year storm, there would be minor flooding of the roads in the station site for a short duration. All openings in the Unit 1 building below grade level that led into the Unit 2 excavation are closed and waterproofed. Therefore, runoff and drainage into the Unit 2 excavation does not have any effect on Unit 1 structures or its operation. (EGC 2020a)

The roofs of safety-related structures are designed to withstand the snow and ice loads due to a winter probable maximum precipitation event over a 100-year recurrence interval antecedent snowpack. Conservatively assuming that the roof drains are clogged at the time of precipitation, the maximum accumulation of water on the roofs of safety-related structures is limited by the height of the parapet walls. (EGC 2020a)

In addition, the passive drain system of the Unit 2 pit serves as a continual collection point for shallow groundwater. The Unit 2 pit drain system consists of several interconnected collection and drainage pipes installed just below the base of the pit, which is covered with concrete. A concrete collection trough in the northern corner of the pit also serves as a collection point to the drainage system. The entire passive drainage system leads to a pipe that runs under the Reactor Building. The invert elevation of the drainage system is approximately 695 feet MSL and gravity drains to Clinton Lake, which has a typical surface elevation of 690 feet MSL.

Any shallow groundwater inflowing to the PA is likely discharged through a combination of collection and discharge by the Unit 2 pit drainage and collection system, through natural seeps along the western hillside upslope of the screen house, or through flow within the porous backfill surrounding the large diameter shutdown service water system (SX) intake pipe present at the west end of the PA. Water that collects within the Unit 2 pit is drained by gravity through the Unit 2 circulating water pipe to a juncture with a drain pipe that exits directly to the lake south of the screen house (EGC 2020a).

Stormwater discharges associated with CPS industrial activities are regulated and controlled through NPDES Permit No. IL0036919 issued by the IEPA (IEPA 2021b). CEG also maintains and implements a SWPPP that identifies potential sources of pollution, such as erosion, which would reasonably be expected to affect the quality of stormwater. It also identifies BMPs that would be used to prevent or reduce the pollutants in stormwater discharges.

3.6.1.2.3 Sanitary Wastewaters

Sanitary water is supplied from Clinton Lake (EGC 2020a). The CPS STP was constructed and designed to achieve compliance with federal and state water quality standards, which are incorporated into the NPDES permit, discussed in Section 3.6.1.2.1. The STP does not connect to any system that might discharge radioactive materials (EGC 2020a). The STP serves in the collection, storage, processing, and ultimate discharge of all treated sanitary waste from CPS. Sanitary waste from the station area is treated to meet the requirements in the NPDES permit. Raw sewage enters the system at the influent wet well. Sewage treatment consists of primary and secondary aerated lagoon cells (EGC 2020a). The primary aerated lagoon has four aerator motors that provide oxygen for bacteria. Flow from the primary aerated lagoon to the secondary aerated lagoon is controlled by draw-off valves. The sewage treatment lagoons are clay lined. Sanitary effluent is normally treated by tertiary sand filtration before release to the circulating water discharge flume (EGC 2020a). There are two identical traveling bridge filters capable of processing 144,000 gallons per day (gpd) (100 gpm). The filters are sand filters designed to produce an effluent TSS quality of <12 parts per million (ppm), which ensures compliance with the NPDES permit. (EGC 2020a; IEPA 2021b)

The sewage treatment system includes effluent sampling and flow measurement from internal outfall A02. (EGC 2020a; IEPA 2021b) Effluent samples are taken at the effluent metering manhole. Flow that passes through the effluent metering manhole is discharged to the station discharge flume.

3.6.1.2.4 Dredging

The UHS is inspected annually by sonar to determine condition, depth, and whether dredging is needed. Since CPS became operational, the UHS has been dredged once in 1991. Based on level tracking, dredging would likely be required during the LR term. Dredge spoils are stored on the CPS site south of the station. The discharge from the dredge disposal location is included in the NPDES permit at Outfall 015 (Figure 3.6-3). (IEPA 2021a)

The UHS is monitored for sediment accumulation periodically and after a major flood passes through the cooling lake. Dredging takes place if the volume of accumulated sediment reaches 218 acre-feet. (EGC 2020a) The UHS monitoring program consists of a visual inspection of the UHS shoreline, including the abutments of the UHS submerged dam, to detect scour or erosion around it; a sediment survey of the UHS and immediate area upstream; a hydrographic survey of the UHS submerged dam; and a physical inspection of the submerged dam, the shutdown service water outlet structure, and intake screen house. The monitoring program is performed annually, except for sedimentation accumulation monitoring, which is done periodically as required to maintain the required UHS volume. (EGC 2020a)

On November 21, 2018, CPS and IDNR jointly applied to the U.S. Army Corps of Engineers (USACE) to replace a control structure valve and pipe and to dredge the west fish rearing pond, located south of the sanitary treatment plant, to increase the viability of fish rearing. On January 25, 2019, the USACE responded stating that the project did not require a Section 404 permit.

3.6.1.2.5 Compliance History

As presented in Chapter 9, no NOVs associated with CPS wastewater discharges to receiving surface waters were issued over the 5-year period of 2018 through 2022.

3.6.1.2.6 Water Temperatures Reporting

As stated in Section 3.6.1, Clinton Lake provides cooling water for Unit 1. CPS measures cooling water intake and discharge temperatures with discharge temperatures measured at the point of initial discharge to the discharge flume and at the second drop (NPDES Outfall 002). Raw data are averaged for each month with the average temperature values for 2018 through 2022 plotted in Figure 3.6-4 (initial discharge temperatures), Figure 3.6-5 (Outfall 002 discharge temperatures), and Figure 3.6-6 (intake temperatures).

The NPDES permit requires continuous thermal monitoring and limits discharge temperatures at Outfall 002, the second drop on the discharge flume. As presented in Section 2.2.3.1, the maximum daily average thermal discharge limit is 110.7°F. In addition, daily average discharge temperatures are permitted to exceed 99°F for a limit of 90 days per calendar year. (IEPA 2021b) Two banks of MDCTs (46 cooling tower cells total) were installed adjacent to the discharge flume in 2018 and 2019 to keep thermal discharges within permit limits. Cooling tower operation is triggered by a flume temperature of 109°F. CPS tracks the number of days that average daily thermal discharge temperatures exceed 99°F. CPS may turn on the cooling towers to reduce the average daily discharge temperature below 99°F to comply with the limit of

90 days per calendar year. During cooling tower operation, hot water is pumped from the discharge flume and fed to the individual towers. Cooled water is returned from the cooling tower basins to the discharge flume. The cooling towers typically operate between May and September. As presented in Section 3.6.1.2.5 and Chapter 9, no NOVs associated with CPS wastewater discharges to receiving surface waters were issued over the 5-year period of 2018 through 2022.

Exelon Generation Company (EGC) submitted a 316(a) Demonstration study dated March 28, 2016, as part of a NPDES permit renewal application to justify continued operations under the permitted thermal limits. A thermal survey of Clinton Lake was conducted in 2015 to characterize the spatial and temporal extents of the thermal plume from CPS's discharge. The model used a one-day average surface (top 2 feet) temperature of 108.1°F. This one-day lake temperature was predicted within 0.20 miles upstream and 0.50 miles downstream of the discharge and laterally across Salt Creek. The temperature decreased to 105°F 1.2 miles downstream of the discharge and less than 100°F 3.3 miles upstream of the discharge. Surface temperatures were less than 90°F approximately 5 miles downstream of the discharge. The maximum one-day average temperature at the spillway was 83.1°F.

3.6.2 Groundwater Resources

3.6.2.1 Groundwater Aquifers

CPS lies within the Central Lowlands physiographic province. Aquifers in the Central Lowlands occur in unconsolidated sand and gravel of Quaternary age and consolidated sandstone, limestone, and dolomite of Paleozoic age. (NRC 2006) Unconsolidated deposits of Quaternary glacial drift and stream alluvium overlie thick sequences of Paleozoic sedimentary rock throughout most of Illinois. The aquifer systems within 50 miles of CPS are found in the following geologic environments, in descending order:

- Alluvial deposits along streams;
- Glacial drift, including layers and lenses of sand and gravel within and between the various tills;
- Glacial outwash (Kansan Stage) in buried bedrock valleys;
- Bedrock of Pennsylvanian age, consisting of shale, siltstone, limestone, sandstone, underclay, and coal;
- Bedrock of Silurian, Devonian, and Mississippian ages, predominantly dolomite and limestone;
- Bedrock of Cambrian-Ordovician age, consisting of a sequence of limestone, dolomite, and sandstone. (EGC 2006)

Alluvial deposits (Henry Formation) in the vicinity of the CPS UHS consist of fine-grained floodplain deposits overlying coarse-grained outwash. The floodplain deposits are commonly silt with some fine sand and clay. The total thickness of the alluvial deposits varies from 6 to 48 feet in the UHS and averages 18.5 feet. Floodplain deposits range from 0 to 23.2 feet thick and average 9.1 feet thick. Alluvial deposits, consisting of varying amounts of clay, silt, sand, and gravel, occur in the valleys of many streams in the region. The alluvium may be used for groundwater supply; however, alluvial aquifers are not used extensively in the area because floodplain areas have undergone minor development. The public water supply for Heyworth, in McLean County, is obtained from alluvial deposits along Kickapoo Creek. Pumping tests showed the aquifer to be capable of supplying over 200 gpm. (EGC 2020a).

The sequence of glacial drift exposed in the CPS power block excavation consists of the Wisconsinan Richland Loess, Wedron Formation, and Robein Silt, and the Illinoian Glasford Formation. The total thickness of the glacial drift in the station area varies from 229.9 to 250.3 feet and averages 237.4 feet. Illinoian till (Glasford Formation) underlies all alluvial deposits. Several sand lenses within the till were penetrated by the station site borings. A nearly continuous layer of fine sand is at the top of the Wedron Formation. Most of the lenses occur between elevations 650 and 730 feet and range in thickness from several inches to 22 feet. (EGC 2020a) The groundwater table in the upper glacial deposits beneath CPS generally occurs within 15 feet bgs.

Groundwater in the glacial drift is derived from precipitation, underflow through bedrock and bedrock valleys, and induced filtration from streambeds. Recharge to the sand and gravel deposits occurs primarily by vertical leakage of infiltrating precipitation. Groundwater in the glacial drift aquifers is discharged to streams that intersects the aquifers, to the underlying glacial deposits, to the Pennsylvanian bedrock, and to pumping wells. (EGC 2020a)

Kansan deposits occur primarily as outwash deposits in buried bedrock valleys. Outwash deposits consist of sand and gravel with varying amounts of silt or clay. The Kansan Banner Formation consists of a complex sequence of stratified silt, sand, clay till, and sand and gravel outwash. Outwash deposits range from 0 to 41 feet thick and average 9.2 feet thick; the thickest outwash deposits are located over an apparent terrace on the north side of the valley. Outwash deposits were observed to be continuous in the foundation excavation for the UHS dam. The base of the outwash in the borings ranges in elevation from 678.3 to 650.5 feet with the most frequently reported base elevations in the interval between 667 and 657 feet. (EGC 2020a)

Groundwater in the Kansan and Illinoian deposits occurs under artesian conditions. Within 15 miles of CPS, the most productive aquifer consists of Kansan outwash deposits (Mahomet Sand Member) in the buried Mahomet Bedrock Valley and its tributaries. (EGC 2020a)

Pennsylvanian bedrock consists largely of shale and siltstone interbedded with limestone, sandstone, underclay, and coal (EGC 2006). The Bond, Modesto, Carbondale, Spoon, and Abbott Formations make up Pennsylvanian bedrock (EGC 2020a). Small amounts of groundwater may be obtained from wells penetrating beds of sandstone, creviced limestone, and fractured shale and coal. Recharge to the Pennsylvanian bedrock occurs by vertical leakage from the overlying glacial drift. Groundwater in the bedrock is under artesian conditions and is discharged to lower bedrock formations or to the glacial drift in those areas where the potentiometric surface of the Pennsylvanian aquifers is higher than that of the glacial aquifers. Most wells in the Pennsylvanian bedrock extend less than 100 feet below the bedrock surface because the formations become tighter, and mineralization of the groundwater increases with depth. Bedrock is used as a source of domestic water supply in the regional area only where conditions are unfavorable for the development of drift aquifers. (EGC 2006)

Mississippian rocks that are aquifers are generally composed of thick-bedded limestone and siltstone. However, these aquifers are typically used for water supply when they are less than 200 feet below land surface and when more water can be obtained from them than from the overlying surficial aquifer system. Water is typically under confined conditions where the water-yielding zones lie beneath clay or shale beds. Recharge to the Mississippian aquifers occurs primarily by water that percolates downward through the unconsolidated materials and the Pennsylvanian bedrock. (EGC 2020a)

Dolomites and limestone of Silurian-Devonian age constitute some of the aquifers in the area. The aquifer portion of the rock lies beneath the upper Devonian shale, Mississippian rocks, or Quaternary deposits. This aquifer generally contains freshwater to about 500 feet below the ground surface. The base of freshwater coincides approximately with the base of the aquifer. Underlying Ordovician shale impedes the downward movement of freshwater. Groundwater is generally under confined conditions and moves through fractures, bedding planes, and solution cavities. (EGC 2006)

Cambrian and Ordovician rocks, mainly marine sandstone, and carbonate rocks, form the Cambrian-Ordovician aquifer system. The aquifer system lies on the Precambrian basement, regarded as a regional confining unit. Regional groundwater discharge from the aquifer system is mainly diffuse upward leakage from confined aquifers along flow paths toward the structural basins. Very saline water around and brines within the basins restrict regional flow into the basins, forcing groundwater to discharge upward. Water in intermediate flow systems discharges upward to the major river valleys. (Young 1992)

3.6.2.2 Hydraulic Properties

The hydraulic connection between Clinton Lake and nearby aquifers results in a rise of the water table for those aquifers in proximity to the lake. Given the relatively small fluctuations of lake water surface elevation, it is not expected that the water table in these aquifers would vary significantly. (NRC 2006)

Within the PA, the shallow groundwater and intermediate groundwater zones are in equilibrium due to the construction of relatively deep building foundations (turbine and reactor buildings). The construction of these buildings required the removal of the less permeable Wedron clay till. The resulting excavation and construction extended to the deeper intermediate sand zone allowing for the potential of shallow impacts to affect the deeper intermediate zone. Outside of the PA, low permeable soils within the Wedron clay till isolate the intermediate groundwater from any impacted shallow groundwater. In addition, the construction of the SX intake pipe, extending from the west end of the turbine building to the screen house, required the excavation of the low permeable Wedron clay till and allowed for the emplacement of porous backfill to surround the pipe. The Unit 2 pit, which is approximately 35 feet deep, extends below the water table and provides a localized hydraulic low point for the collection of shallow groundwater. As discussed in Section 3.6.1.2.2, the collected groundwater discharges into Clinton Lake.

Two shallow groundwater zones are established for CPS. A shallow water table zone exists within the clayey-silt Wedron clay till. A deeper intermediate zone exists within the pre-Illinoian sand unit. In shallow overburden, the hydraulic gradient is estimated to be 0.05. The Wedron clay till has a hydraulic conductivity value of 0.01 feet per day (ft/day). The horizontal groundwater flow velocity in the overburden shallow zone is approximately 0.0016 ft/day, or approximately 0.6 ft per year, using an estimated saturated porosity of 32 percent. The average hydraulic gradient in intermediate overburden is estimated at 0.008. A hydraulic conductivity of 28 ft/day was used for the intermediate sand zone. Using an estimated saturated porosity of 32 percent, the horizontal groundwater flow velocity is approximately 0.7 ft/day, or 255 feet per year.

Three monitoring well nests (MW-CL-13S/I, MW-CL-15S/I, and MW-CL-18S/I) were installed with wells in the shallow till and in the intermediate sand, in part, to determine the vertical hydraulic gradient. During the second quarter 2018 sampling event, downward vertical hydraulic gradients ranged from 0.31 feet per foot (ft/ft) (MW-CL-13S/I) to 0.48 ft/ft (MW-CL-15S/I).

During CPS site investigations, falling-head permeability tests were performed on samples collected from the Clinton Lake Dam and CPS sites in piezometers to estimate average horizontal permeability. Average horizontal permeability values ranged from 1.2×10^{-6} to 2.6×10^{-6} centimeters per second (cm/s) in the Wisconsinan till (Wedron Formation) and 6.1×10^{-6} to 1.4×10^{-5} cm/s in the Illinoian till (Glasford Formation). (EGC 2020a)

Vertical permeability in the Henry Formation is 1.8×10^{-8} cm/s for the fine-grained floodplain deposits. Vertical permeability of sand samples from the weathered portion of the Glasford Formation averages 2.1×10^{-3} cm/s ranging from 1.8×10^{-4} to 4.7×10^{-3} cm/s. In the unaltered Glasford Formation, the vertical permeability ranges from 3.8×10^{-9} to 2.3×10^{-7} cm/s and averages 3.8×10^{-8} cm/s. Porosity is 16.5 percent. Porosity in the Illinoian till ranged from 16.3 to 24 percent. Porosity of the interglacial zone ranged from 14.8 to 40 percent. (EGC 2020a)

Aquifers associated with the Mahomet Bedrock Valley and the ancient Mississippi Bedrock Valley are the only highly productive, nonalluvial sand and gravel aquifers in southern Illinois. Deposits filling the valley include the widespread Mahomet Sand Member are as much as 200 feet thick. With hydraulic conductivities as high as 570 ft/day, a horizontal hydraulic gradient of 0.0002 ft/ft, and an assumed porosity of 25 percent, average linear groundwater velocities in this material are estimated at 0.45 ft/day. (EGC 2006)

The permeability of outwash deposits is approximately 2.8 ft/day to 28 ft/day (EGC 2020a). Wells near the margins of the Mahomet Bedrock Valley may produce as much as 500 gpm.

Wells located in the center of the valleys might yield substantially higher quantities of groundwater on a sustained basis given proper well construction and management. Most wells in this area do not produce from this zone, however, because adequate supplies for domestic, agricultural, and most municipal purposes may be developed from the alluvium along stream courses or from small permeable lenses in the upper glacial drift materials. Vertical permeability for till with some sand and gravel averages 0.02 gpd per square foot (1.0 x 10^{-6} cm/s). (EGC 2020a)

Well yields in the Pennsylvanian aquifers range from less than one to about 100 gpm, with an average well yield of about 10 gpm. Well yields in Mississippian aquifers range from one gpm to 100 gpm, with an average of about 10 gpm. In the Silurian-Devonian aquifer, probable well yields range from less than 250 gpm to 500 gpm. (EGC 2006)

3.6.2.3 Potentiometric Surfaces

The water table in the CPS vicinity occurs as a ridge-like mound in the Wisconsinan till between Salt Creek and North Fork of Salt Creek. The position of the groundwater ridge marks a recharge area from which groundwater flows to the southeast toward Salt Creek and to the northwest, across the station site, toward North Fork of Salt Creek. (EGC 2020a)

In the area surrounding the PA, shallow zone overburden groundwater flows radially inward towards the main PA structures and the former Unit 2 pit. Shallow groundwater inflow in the PA area is likely discharged to Clinton Lake through the deeper more permeable intermediate zone, through the backfill surrounding the SX Intake Pipe, and through natural seeps along the steep slopes existing west of the screen house. Shallow overburden groundwater is forced to flow around the major station structures that are completed into the underlying deeper sediments. Outside of the PA, shallow zone groundwater generally flows radially outward from the station ultimately discharging to Clinton Lake.

Intermediate zone groundwater flows west to east under a relatively shallow gradient. Intermediate overburden groundwater is forced to flow around the major station structures that are completed into the underlying deeper sediments.

Using the May 2018 water level data for the shallow aquifer and intermediate zone, the overburden groundwater flow in the immediate area of the PA is toward the main station structures and the Unit 2 pit. Shallow groundwater outside of the PA area flows radially outward with ultimate discharge to Clinton Lake. A groundwater divide exists along the west and south sides of the PA. The intermediate flow zone has a general groundwater flow direction of southeast to northwest. The intermediate zone also discharges to Clinton Lake. Both the shallow and intermediate flow zones are influenced by the main station structures within the PA.

The groundwater flow is impacted by station structures and local geology. The foundation of the reactor building was installed to elevations of 702 to 712 feet MSL, below the shallow and intermediate zones. The foundations of the reactor and turbine buildings are completed into deeper sediments at depths greater than the static water table; therefore, groundwater flow in the shallow and intermediate overburden migrates around these buildings.

Groundwater potentiometric maps of the shallow and intermediate groundwater zones are provided as Figures 3.6-7 and 3.6-8, respectively. The groundwater potentiometric surface maps are based on groundwater level data collected in May 2018 as part of the groundwater protection initiative (GPI) program of the Nuclear Energy Institute (NEI), which is discussed in Section 3.6.2.4.

3.6.2.4 Groundwater Protection Program

In May 2006, the NEI implemented the GPI, an industry-wide voluntary effort to enhance nuclear power plant operators' management of groundwater protection (NEI 2007). Industry implementation of the GPI identifies actions to improve licensee management and response to instances where the inadvertent release of radioactive substances may result in detectable levels of plant-related materials in subsurface soils and water, and also describes communication of those instances to external stakeholders. Aspects addressed by the initiative include site hydrology and geology, site risk assessment, on-site groundwater monitoring, and remediation. In August 2007, NEI published updated guidance on implementing the GPI as NEI 07-07, Industry Ground Water Protection Initiative-Final Guidance Document (NEI 2007). This guidance was further updated in February 2019. The purpose of NEI 07-07 is to improve the management of situations involving inadvertent radiological releases that get into groundwater and to improve communications with external stakeholders to enhance trust and confidence on the part of local communities, states, the NRC, and the public in the nuclear industry's commitment to a high standard of public radiation safety and protection of the environment. (NEI 2019)

This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to groundwater (NEI 2019). In 2006, EGC instituted a program to evaluate the impact of station operations on groundwater and surface water in both on and off station property (EGC 2022a). A hydrogeologic investigation was conducted at CPS in 2006 to evaluate the potential that groundwater at or near the generating station was impacted by releases of radionuclides. Fourteen shallow and intermediate monitoring wells were installed. The intermediate wells are approximately 25 feet deeper than the shallow wells. Eight of the 10 shallow wells are screened in the Wedron Formation, and the four intermediate wells are screened in the Glasford Formation. Three 5-year update hydrogeologic investigation reports were prepared for CPS in May 2011, January 2014, and September 2018. In 2020, EGC modified the corporate radiological groundwater protection program (RGPP) to include modified sample location designations and analytical procedural requirements. The RGPP sample location designations include background, long-term shutdown, mid-field, perimeter, and source wells. CPS monitors 17 wells as part of the RGPP: 3 background, 4 perimeter, and 10 source designated wells. Groundwater quality data are presented in Section 3.6.4.2. Sample frequency and analyses are listed below.

- Background: Hydrogeologically upgradient groundwater monitoring wells at a distance from potential sources of licensed material. Groundwater at these wells is presumed to be representative of background concentrations for radionuclides, unaffected by station releases, emissions, spills, or by unusual natural exposure. Background wells MW-CL-15I, MW-CL-15S, and MW-CL-20S are sampled annually for tritium and every 2 years for gamma-radionuclide analysis.
- Perimeter: Groundwater monitoring wells installed along the downgradient and cross-gradient perimeter of areas with high-risk systems or components. Perimeter wells B-3, MW-1, MW-2, and MW-CL-13I are sampled annually for tritium and every 2 years for gamma-radionuclide analysis.
- Source: Groundwater monitoring wells installed close to higher risk systems or components where leak detection capability is recommended. Source wells are sampled quarterly for tritium; annually for Sr-89 and Sr-90 analyses; every 2 years for gamma-radionuclide and gross-alpha; and every 5 years for Fe-55 and Ni-63. Sampling locations are monitor wells MW-CL-12I, MW-CL-13S, MW-CL-14S, MW-CL-16S, MW-CL-17S, MW-CL-18I, MW-CL-18S, MW-CL-19S, MW-CL-21S, and MW-CL-22S.

Surface water sampling locations were included in the RGPP prior to the 2020 RGPP revision. CEG made a fleetwide decision in 2020 to realign RGPPs to the objective of NEI 07-07, which involves management of inadvertent releases of licensed material to groundwater. Therefore, surface water sampling is no longer included in the RGPP.

The long-term objectives of the RGPP are as follows (EGC 2022a):

- Identify suitable locations to monitor and evaluate potential impacts from station operations before significant radiological impact to the environment and potential drinking water sources.
- Understand the local hydrogeologic regime in the vicinity of the station and maintain knowledge of flow patterns on the surface and shallow subsurface.
- Perform routine water sampling and radiological analysis of water from selected locations.
- Report new leaks, spills, or other detections with potential radiological significance to stakeholders in a timely manner.
- Regularly assess analytical results to identify adverse trends.
- Take necessary corrective actions to protect groundwater resources.

Figure 3.6-7 shows the locations of onsite groundwater monitoring wells, including monitoring wells that are not part of the RGPP. Well construction details are presented in Table 3.6-3.

3.6.2.5 Sole Source Aquifers

A sole source aquifer (SSA), as defined by the EPA, is an aquifer that supplies at least 50 percent of the drinking water consumed by the area overlying the aquifer, and there is no reasonably available drinking water source should the aquifer become contaminated. The SSA program was created by the U.S. Congress as part of the Safe Drinking Water Act (SDWA) and allows for the protection of these resources. (EPA 2022b) All proposed projects receiving federal funds are subject to review to ensure they do not endanger the water source.

CPS is in EPA Region 5, which has oversight responsibilities for the public water supply in Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, and 35 Tribal Nations. CPS is over the Mahomet Aquifer SSA. (EPA 2022b) EPA designated a portion of the Mahomet Aquifer system in east-central Illinois as an SSA in 2015. More than half of the population in east-central Illinois relies on the Mahomet Aquifer system as a source of drinking water. The Mahomet Aquifer system is an underground layer of water-bearing sand and gravel that fills a wide bedrock valley in an area that includes 14 east-central Illinois counties. The aquifer system provides about 58 million gallons of drinking water each day for 120 public water systems and thousands of rural wells that serve about a half million people in Illinois. (EPA 2015)

3.6.3 Water Use

3.6.3.1 Surface Water Use

The primary purpose of Clinton Lake is to provide water required for operating CPS (EGC 2006). CPS sources its cooling water from Clinton Lake (IEPA 2021a). The cooling water system consists of a cooling lake, CWIS, condensers, and a discharge flume (IEPA 2021a). Potable water is obtained from Clinton Lake at the screen house.

The screen house is the CWIS, which provides a continuous supply of water to the Unit 1 reactor and non-contact cooling system. The screen house is a shoreline structure that is situated on the North Fork arm of Clinton Lake and extends approximately 100 feet into the waterbody. The CWIS was designed with 14 bays for two potential operating units; however, seven bays are unused for Unit 2, which was not constructed. Of the seven Unit 1 bays, six provide cooling water to the circulating water pumps and one provides water to the service water pumps. There are three circulating water pumps, two service water pumps, and one standby service water pump in the screen house. (IEPA 2021a)

Cooling water passes through the station and cools the condensers for the BWR. The water then enters the Seal Well, which keeps the circulating water piping full. The water then reaches the discharge flume, which discharges the water to the Salt Creek arm of Clinton Lake. The discharge flume has a bottom width of 120 feet and returns the water from the facility to Clinton Lake. (IEPA 2021a)

The makeup water pump house pretreating system uses up flow filtration and reverse osmosis to provide filtered and potable water for station needs. The MWPH also contains a mixed bed polisher system (demineralizer). The combination of reverse osmosis and mixed bed polishers provides a supply of demineralized water for station equipment and systems. Fire protection water is drawn from the UHS, which is sized to include 900,000 gallons of water for fire protection (EGC 2020a).

Tritium-containing materials are stored and treated within the radwaste building and excess liquids are stored within the cycled condensate storage tank. CPS uses evaporators, filters, demineralizers, and carbon beds in the radwaste building to treat the effluent. The liquid radioactive waste system has not discharged since 1992, and there are no planned discharges from the liquid radwaste system.

Evaporation from the large surface area of Clinton Lake reduces the total amount of water available to flow downstream of the dam (NRC 2006). Natural lake evaporation in the Salt Creek basin is approximately 35.67 inches per year, with the highest evaporative loss occurring in the summer months and the least evaporative loss occurring during the winter months (EGC 2020a). In addition to this natural evaporation, induced evaporation results from heat added to the waters of Clinton Lake from the once-through heat dissipation system of Unit 1. These two components (presence of the lake plus reject reactor heat) combine to produce evaporation rates that likely exceed the historical pre-impoundment evapotranspiration rates that would have occurred in the area that the lake inundated. Therefore, the presence of the lake and the discharge of heat to the lake from the existing CPS unit increased evaporation and reduced the total quantity of water available for release downstream of the dam. (NRC 2006)

The existing CPS unit is the only significant consumptive and non-consumptive water user of Clinton Lake. When Unit 1 is operating, pumps draw water from Clinton Lake at a range of 566,000 gpm in the summer and 445,000 gpm in the winter. However, most of the CPS water usage is non-consumptive. The large volume of water withdrawn from Clinton Lake for condenser cooling is entirely returned to the lake. While there is no consumptive use of water between intake and discharge, the elevated temperature of the discharged water results in some induced evaporative losses from Clinton Lake. (NRC 2006) Estimates of water consumption due to evaporative loss from cooling towers are not available.

There are no known surface water users of Salt Creek or Sangamon River water that could be affected by accidental or normal releases of contaminants. There is no municipal or private use of Salt Creek or the Sangamon River for drinking purposes. This is also true for the Illinois River, into which the Sangamon River flows. The closest user of downstream water for drinking purposes is Alton, Illinois, on the Mississippi River, 242 river miles from CPS. There is no known usage of Salt Creek water for irrigation in DeWitt, Logan, Menard, or Cass Counties. While irrigation farming occurs in this region, well water is the primary source of irrigation water. In DeWitt County, there are no irrigated farms. (EGC 2020a)

Estimated station water requirements are summarized below:

- Circulating water system: 565,800 gpm summer, 445,000 gpm winter, and 565,800 gpm

Unit 1 shutdown. (EGC 2020a)

- Station service water system: 37,500 gpm summer, 7,500 gpm winter, and 37,500 gpm Unit 1 shutdown. (EGC 2020a)
- SX: 10,500 gpm Unit 1 shutdown. (EGC 2020a)

The average surface water withdrawal rate by CPS in 2022 was reported as 804.75 MGD and averaged 763.06 MGD and averaged 763.06 MGD between 2018 and 2022 (Table 3.6-4a). A summary of monthly surface water withdrawals reported by CPS between 2018 and 2022 is included as Table 3.6-4b.

In 2015, total surface water withdrawals in DeWitt County were reported as 751.83 MGD, of which 751.81 MGD was used for power generation. There were no reported surface water withdrawals in Piatt County to the west of CPS. (USGS 2018) A summary of surface water use in these two counties is presented in Table 3.6-5.

3.6.3.2 Groundwater Use

Groundwater is not used at CPS, nor is dewatering conducted. As presented in Section 3.6.3.1, CPS sources its cooling water and potable water from Clinton Lake. In addition, there are no discharges to groundwater from CPS requiring permits by regulatory agencies. Although not used for station operations, two potable wells are located on CPS property.

- Well API 120392153600 is located in the personnel beach recreation area. There are no available well construction details for this water supply well. (ISGS 2022) It provides drinking water at the personnel beach recreation area as Water System No. IL3111153 (Chapter 9). The well is used in the summer when the beach area is open, and the well is shut down each winter. CPS does not measure groundwater withdrawals in this well.

- A potable well on the southern portion of the CPS station property serves as a primary supply for the village of DeWitt. This well, identified by well identifier 47642 and API 120392062100, is approximately 1 mile south of the PA. The well was installed in 1974. It was cased to 300 feet bgs with intake between 300 and 340 feet bgs. (ISGS 2022)

Aquifers in the CPS area are described in Section 3.6.2.1. Public water supplies in the region are derived mainly from groundwater sources (EGC 2020a). Groundwater supplies are obtained chiefly from the glacial outwash in the buried bedrock valleys and shallower unconsolidated deposits and, to a minor extent, from the upper 100 feet of the Pennsylvanian rock sequence beneath the glacial drift. However, the public water supply for Heyworth, in McLean County, is obtained from alluvial deposits along Kickapoo Creek. The lower bedrock aquifers are not used for water supply in the CPS area since adequate supplies for municipal, agricultural, and domestic requirements are more easily obtained from the shallower bedrock or the overlying unconsolidated materials. Moreover, poor quality water in the deeper aquifers is typical in this region. (EGC 2020a)

Within 15 miles of CPS, approximately 65 percent of the total public groundwater supplies is pumped from the Mahomet Bedrock Valley aquifer. Except for alluvial wells at Heyworth, the remaining public water supplies are pumped from wells in the Wisconsinan, Illinoian, and Kansan glacial deposits. Bedrock wells are not used in any public water supply system. (EGC 2020a)

Domestic wells near CPS vary in depth from 18 to 413 feet bgs and produce from both glacial till sand and gravel lenses within the overburden and from the underlying bedrock aquifer. Use of deep bedrock groundwater supply is limited due to poor regional water quality and the availability of shallow sources of potable groundwater. In the area, the largest volumes of groundwater are extracted from the deep sand and gravel aquifers. These deep aquifers are the principal source of drinking water for many municipalities in the region. Individual wells may produce up to 500 gpm.

In 2015, groundwater withdrawals in DeWitt County were reported as 2.5 MGD, with zero withdrawals for power generation. The greatest groundwater withdrawals were for public supply (1.31 MGD). Groundwater withdrawals in Piatt County were 5.17 MGD. The largest groundwater users were industrial (3.36 MGD) and public supply (1.12 MGD). (USGS 2018) A summary of groundwater use in these two counties is presented in Table 3.6-6.

A list of 19 offsite registered water wells within a 2-mile radius from the CPS center point is presented in Table 3.6-7. These wells are also mapped in Figure 3.6-10.

3.6.4 Water Quality

3.6.4.1 Surface Water Quality

As presented in Section 3.6.1, CPS is in DeWitt County in east-central Illinois approximately 6 miles east of the city of Clinton on a peninsula between the North Fork and Salt Creek arms of Clinton Lake. Clean Water Act (CWA) Section 305(b) requires each state to report to the EPA every 2 years on the condition of its surface waters, and Section 303(d) requires each state to report on its impaired water bodies (those not meeting water quality standards). A review of the IEPA's 2020/2022 303(d) list of impaired waters and the IEPA Integrated Report Web Application included the following impaired waters within a 6-mile radius of CPS.

- Clinton Lake, Assessment Unit ID (AUID) IL_REI, aesthetic quality, total phosphorus and cause unknown.
- Coon Creek, AUID IL_EII-01, aesthetic quality, oil, aquatic life, dissolved oxygen.
- Friends Creek, AUID EL_EV-02, aquatic life, dissolved oxygen.
- North Fork Salt Creek, AUID IL_EIJ-01, aquatic life, cause unknown.
- Salt Creek, AUID IL_EI-06, aquatic life, dissolved oxygen. (IEPA 2022a)

The known permitted discharges to Clinton Lake are limited to those from the existing unit. These sources and permitted discharge limits are described in the NPDES permit. (IEPA 2021b) CPS follows its NPDES permit, discussed in Section 3.6.1.2.1.

CPS previously collected surface water samples from six locations across the station (SW-CL-1, SW-CL-2, SW-CL-4, SW-CL-5, SW-CL-6, and SW-CL-7) as part of its RGPP prior to the 2020 RGPP revision (Section 3.6.4.2). Surface water locations were sampled since 2006 for tritium and gamma-emitting radionuclides. Annual surface water quality data collected as part of the RGPP were reported in an Appendix F of the annual radiological environmental operating reports (AREORs). Tritium was not detected in surface water samples in 2018 through 2020. (EGC 2019a; EGC 2020b; EGC 2021b). No surface water samples were collected in 2021 and 2022 as part of the RGPP (EGC 2022a; CEG 2023a). As presented in Section 3.6.2.4, surface water sampling was removed from the RGPP in 2020.

As part of the radiological environmental monitoring program (REMP), CPS collects surface water samples at locations between 0.4 and 6.1 miles from the CPS station. Samples are analyzed for tritium and gamma-emitting nuclides, which were not detected in surface water samples collected in 2018 through 2022, and the lower limits of detection (LLDs) were met. (CEG 2023a; EGC 2019a; EGC 2022a; EGC 2021b; EGC 2020b)

3.6.4.2 Groundwater Quality

During the site planning for CPS, groundwater with high naturally occurring methane was collected in a test well. Therefore, the CPS water requirements have been met by surface water resources (Clinton Lake) rather than from groundwater. (ECG 2006)

Alluvial deposits, consisting of varying amounts of clay, silt, and gravel, occur in the valleys of many streams in the regional area. The alluvium may be used for groundwater supply in those areas where thick, permeable sand and gravel deposits are present. The following concentrations were reported for selected chemical constituents in groundwater from the alluvial aquifer: 284 ppm hardness (as $CaCO_3$), 240 ppm alkalinity (as $CaCO_3$), 16 ppm chloride, 0.4 ppm total iron, and 329 ppm total dissolved minerals. (EGC 2020a)

Water from wells tapping Wisconsinan aquifers generally has a lower mineral content than water from wells in the deeper formations. However, the quality of groundwater obtained from Wisconsinan aquifers is more variable, which in part is due to local contamination of shallow wells from nearby pollution sources, such as septic tanks and feedlots. Iron content in water from the deeper wells almost always exceeds the recommended upper limit of 0.3 milligrams per liter (mg/L) set by the U.S. Public Health Service. The high chloride content reported for some wells in the Illinoian and Kansan aquifers suggests that some highly mineralized water is being discharged from the Pennsylvanian bedrock to the overlying glacial deposits in some areas. (EGC 2020a)

The RGPP monitoring network consists of 17 groundwater monitoring wells: 3 background, 4 perimeter, and 10 source wells. As described in Section 3.6.2.4, samples obtained from these wells are analyzed at different frequencies for tritium, gamma-radionuclide, gross-alpha (dissolved and suspended), hard-to-detect radionuclides (Fe-55 and Ni-63), and/or Sr-89 and Sr-90.

Tritium was detected in 2022 above 200 picoCuries per liter (pCi/L) at a maximum concentration of 383 pCi/L in well MW-CL-14S. Based on analytical data collected in 2022, there does not appear to be any active sources of tritium to groundwater. Over the last 5 years, tritium has been detected in wells MW-CL-14S (concentrations ranging from 188 ± 122 pCi/L to 1,500 ± 219 pCi/L), MW-CL-16S (concentrations ranging from 236 ± 134 pCi/L to 332 ± 129 pCi/L), MW-CL-21S (concentrations ranging from 193 ± 121 pCi/L to 247 ± 147 pCi/L, MW-CL-22S (concentrations ranging from 221 ± 126 pCi/L to 232 ± 127 pCi/L) and MW-CL-13S (concentrations ranging from 205 ± 131 pCi/L to 309 ± 133 pCi/L). (CEG 2023a; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a) Tritium levels were far below the EPA drinking water standard (and the NRC reporting limit) of 20,000 pCi/L (EGC 2022a).

Gross-alpha (dissolved and suspended fractions) was analyzed annually from 2010 through 2019. In 2020, gross-alpha data was evaluated to establish an alert level for the dissolved and suspended gross-alpha fractions. An alert level is three times the ongoing average gross-alpha concentration for each RGPP monitoring well that had gross-alpha analyzed more than once and would continue to be monitored during future RGPP sampling rounds. The alert level would be able to account for fluctuations in naturally occurring alpha activity in the area of wells and identify outliers that may indicate a potential release. Beginning in 2021, select transuranic were analyzed if a gross alpha concentration exceeded the alert level in a particular well to ensure that licensed material is not present in groundwater. If the results of the select transuranics analysis showed no unusual activity, the gross-alpha result that triggered the select transuranics analysis was incorporated into the ongoing average concentration for that well. Gross-alpha (dissolved and suspended) was not detected at concentrations exceeding the alert level in the samples collected in 2021. Samples will be analyzed for gross alpha in 2023. No select transuranics were detected in the sample collected from MW-CL-19S during the second quarter 2022 RGPP sampling round. Gross-alpha (dissolved and suspended) was not detected in any of the groundwater samples in 2018 (EGC 2019a). Dissolved gross-alpha was not detected in groundwater samples in 2019; however, suspended gross-alpha was detected in well MW-CL-14S at 10 ± 1.9 pCi/L in 2019 (EGC 2020b).

Gamma-radionuclide analysis has been performed on RGPP samples (quarterly to annually) at CPS since 2006, which produced over 5,200 data records. Gamma-radionuclides have not been detected at concentrations greater than their respective LLDs in RGPP samples since 2006. In 2020, gamma-radionuclide analysis frequency was reduced to every 2 years. Samples from all wells were analyzed for gamma-radionuclides in 2021. Gamma-radionuclides were not detected above their respective LLDs in samples collected in 2021. All wells will have gamma-radionuclide analysis performed again in 2023. Since 2018, gamma-emitting radionuclides were not detected at concentrations greater than their respective LLDs, as specified in NUREG-1302, in any of the groundwater samples (EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a).

Samples collected from source wells were analyzed for hard-to-detects during the third quarter of 2020. They were not detected at concentrations greater than their respective LLDs. Samples will be analyzed for hard-to-detects in 2025. Since 2018, hard-to-detect radionuclides Fe-55 and Ni-63 were not detected at concentrations greater than their respective LLDs, as specified in NUREG-1302, in any of the groundwater samples (EGC 2019a; EGC 2020b; EGC 2021b).

Since 2018, Sr-89 and Sr-90 were not detected at concentrations greater than their respective LLDs, as specified in NUREG-1302, in any of the groundwater samples (CEG 2023a; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a).

The objectives of the REMP are to provide data on measurable levels of radiation and radioactive materials in the site environs, and to evaluate the relationship between quantities of radioactive materials released from the station and resultant radiation doses to individuals from principal pathways of exposure. Well water samples are analyzed for concentrations of tritium and gamma-emitting nuclides. In 2018 through 2022, no tritium or gross beta activity was detected in the REMP well water samples, and the LLDs were met. (CEG 2023a; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a)

Industrial practices at CPS that involve the use of chemicals are those activities typically associated with painting, cleaning of parts/equipment, refueling of onsite vehicles/generators, fuel oil and gasoline storage, and the storage and use of water treatment additives. The use and storage of chemicals at CPS are controlled in accordance with CEG procedures and a site-specific Spill Prevention, Control, and Countermeasure (SPCC) plan. In addition, as presented in Section 2.2.7, nonradioactive waste is managed in accordance with CPS’s waste management procedure, which contains preparedness and prevention control measures.

3.6.4.2.1 History of Radioactive Releases

Low-level radioactive gases, liquids, and solids are routine byproducts of nuclear power plant operation. Radioactive waste management systems, commonly called radwaste systems, collect, process, and either recycle or dispose of these radioactive materials. The design and operation of the radwaste systems are regulated by the NRC. As part of normal operation of the station, radioactive material must sometimes be discharged to the environment. Such discharges are also regulated by the NRC, and submittal of annual reports to the NRC detailing the amounts and compositions of radwaste discharged intentionally or accidentally from their facilities is required. The EPA has a separate regulation that limits the radioactivity of drinking water. This regulation sets a maximum allowed concentration for each radionuclide in drinking water, including a maximum radioactivity concentration of 20,000 pCi/L for tritium, a radioactive form of hydrogen produced by power plants. There have been no liquid radioactive releases from CPS since 1992. There were no gaseous effluent releases that approached the limits specified in the CPS Offsite Dose Calculation Manual (ODCM) in 2018 through 2022 (CEG 2023a; EGC 2022a; EGC 2021b; EGC 2020b; EGC 2019a).

After a rainfall event on May 3, 2006, a sample was collected from a pit located next to the former cycled condensate storage tank for analysis. Tritium was detected at 7,000 pCi/L. A resample showed similar results. Groundwater impacts related to this spill continue to be monitored under the RGPP. Groundwater flow from the cycled condensate storage tank is toward monitoring well MW-CL-14S. Subsurface utilities in the area, such as cycled condensate underground piping, create preferential pathways within which groundwater flows at increased rates. These preferential pathways allow tritium impacts from the 2006 release to flow towards MW-CL-14S at increased rates. The cycled condensate storage tank was replaced in 2013. The new cycled condensate storage tank is on the south side of the turbine and radwaste buildings.

Tritium was detected in well MW-CL-14S in 2018 through 2022 during at least one sampling event each year. The maximum detected concentration in this well was 1,500 ± 219 pCi/L in March 2021. This was also the maximum tritium detection of all RGPP groundwater samples collected at CPS during this 5-year period, and it is far below the EPA drinking water limit of 20,000 pCi/L. (CEG 2023a; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a)

In the last 5 years (2018−2022), tritium has not been detected above the LLD in any of the intermediate monitoring wells. (CEG 2023a; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a)

3.6.4.2.2 History of Nonradioactive Releases

There are no ongoing or completed nonradiological remediation activities at CPS. There were no reportable spills applicable to federal, state, or local regulations at CPS since 2018.

Table 3.6-1 Clinton Lake Water Levels (2008–2022)

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
2022	690.43	690.80	690.78	690.75	690.71	690.33	690.10	689.66	689.26	688.66	688.46	688.74	689.91
MEAN	690.02	690.32	690.76	690.74	690.86	690.74	690.39	689.85	689.65	689.59	689.67	689.91	690.21
MAX	691.04	691.20	691.13	691.38	691.59	691.59	691.30	690.68	690.80	690.89	691.56	691.41	691.59
	2016	2019	2010	2013	2009	2010	2015	2016	2008	2014	2009	2015	2009
MIN	688.46	688.80	690.05	689.20	689.77	689.58	688.82	688.01	688.15	688.39	688.19	688.33	688.01
	2018	2021	2021	2012	2012	2012	2012	2012	2012	2012	2011	2011	2012

(USGS 2023b)

Note: USGS used incomplete data for statistical calculation

Table 3.6-2 NPDES Water Quality Monitoring Program (Sheet 1 of 4)

Outfall	Description	Parameter	Permit Requirement	Frequency
002	Discharge Flume (Average flow = 965 MGD) 1. Main condenser cooling water 2. Station service water 3. Makeup water treatment system 4. Screen house sump discharges 5. Sewage treatment plant effluent (A02) 6. Radwaste treatment system effluent (B02)	Flow	No limit, report as monthly average and daily maximum in MGD	Daily
		pH	6.0-9.0 standard units (SU), report minimum and maximum values	Monthly grab
		Total residual chlorine	0.05 mg/L daily maximum	Monthly grab
		Temperature	May be ≥99.0°F daily average up to 90 days per calendar year, with 110.7 °F as maximum daily average	Continuous, daily
		Zinc, total	No limit, monitor only	Quarterly grab
		Phosphorus, total	No limit, monitor only	Quarterly grab
A02	Sewage treatment plant effluent (design average flow = 0.088 MGD)	Flow	No limit, report as monthly average and daily maximum in MGD	Daily
		Biological Oxygen Demand (BOD)	22 lb./day 30-day average, 75 lb./day daily maximum; 30 mg/L 30-day average, 60 mg/L daily maximum	Monthly 24-hour composite
		TSS	22 lb./day 30-day average, 75 lb./day daily maximum; 30 mg/L 30-day average, 60 mg/L daily maximum	Monthly 24-hour composite

Table 3.6-2 NPDES Water Quality Monitoring Program (Sheet 2 of 4)

Outfall	Description	Parameter	Permit Requirement	Frequency
		Fecal Coliform	No limit, monitor only	Monthly grab May through October
B02	Radwaste treatment system effluent (Average flow = 0.072 MGD)	Flow	No limit, report as monthly average and daily maximum in MGD	Daily
		TSS	15 mg/L 30-day average, 30 mg/L daily maximum	Monthly grab
		Oil & grease	15 mg/L 30-day average, 30 mg/L daily maximum	Monthly grab
003	Water treatment wastes (Average flow = 0.288 MGD)	Flow	No limit, report as monthly average and daily maximum in MGD	Daily
		pH	6.0-9.0 SU, report minimum and maximum values	Monthly grab
		TSS	15 mg/L 30-day average, 30 mg/L daily maximum	Monthly grab
		Oil & grease	15 mg/L 30-day average, 20 mg/L daily maximum	Monthly grab
004	Transformer area OWS (Intermittent discharge)	Flow	No limit, report as monthly average and daily maximum in MGD	Monthly estimate
		pH	6.0-9.0 SU, report minimum and maximum values	Monthly grab
		Oil & grease	15 mg/L 30-day average, 20 mg/L daily maximum	Monthly grab

Table 3.6-2 NPDES Water Quality Monitoring Program (Sheet 3 of 4)

Outfall	Description	Parameter	Permit Requirement	Frequency
		TSS	15 mg/L 30-day average, 30 mg/L daily maximum	Monthly grab
005	Diesel generator area OWS (Intermittent discharge)	Flow	No limit, report as monthly average and daily maximum in MGD	Monthly estimate
		pH	6.0-9.0 SU, report minimum and maximum values	Monthly grab
		TSS	15 mg/L 30-day average, 30 mg/L daily maximum	Monthly grab
		Oil & grease	15 mg/L 30-day average, 20 mg/L daily maximum	Monthly grab
006	Screen house intake discharges (Average flow = 0.072 MGD)	Flow	No limit, report as monthly average and daily maximum in MGD	Monthly estimate
007	Safe SX (Average flow = 35 MGD)	Flow	No limit, report as monthly average and daily maximum in MGD	Daily
		pH	6.0-9.0 SU, report minimum and maximum values	Monthly grab
		Total residual chlorine	0.05 mg/L daily maximum	Monthly grab
		Zinc, total	No limit, monitor only	Monthly grab

Table 3.6-2 NPDES Water Quality Monitoring Program (Sheet 4 of 4)

Outfall	Description	Parameter	Permit Requirement	Frequency
		Phosphorus, total	No limit, monitor only	Quarterly grab
008	Unheated pump bearing cooling waters. (Intermittent discharge) This discharge occurs only during refueling and other forced outages	Flow	No limit, monitor only	Once daily estimate when discharging
011	Sedimentation pond runoff (Intermittent discharge)	Maintain SWPPP	No limit	No sampling
015	UHS dredge pond discharge (Intermittent discharge)	Flow	No limit, report as monthly average and daily maximum in MGD	Once daily estimate when discharging
		pH	6.0-9.0 SU, report minimum and maximum values	Once daily grab when discharging
		TSS	15 mg/L 30-day average, 30 mg/L daily maximum	Once daily grab when discharging

(IEPA 2021b)

Table 3.6-3 CPS Groundwater Well and Piezometer Details (Sheet 1 of 2)

Well	Well Diameter[a]	Elevations (feet MSL)					
		Top of Casing	Top of Filter[b]	Top of Screen[b]	Bottom of Screen[b]	Bottom of Filter[b]	Well Construction Material
MW-CL-12I[c]	2	730.99	686.52	730.99	684.52	674.52	Polyvinyl chloride (PVC)
MW-CL-13S[c]	2	738.09	721.25	738.09	719.25	709.25	PVC
MW-CL-13I[c]	2	738.14	679.77	738.14	678.27	668.27	PVC
MW-CL-14S[c]	2	736.04	720.26	736.04	718.26	708.26	PVC
MW-CL-15S[c]	2	735.43	723.9	735.43	721.9	711.9	PVC
MW-CL-15I[c]	2	735.58	687.84	735.58	685.84	675.84	PVC
MW-CL-16S[c]	2	737.8	717.1	737.8	714.6	704.6	PVC
MW-CL-17S[c]	2	738.16	719.28	738.16	717.28	707.28	PVC
MW-CL-18S[c]	2	739.18	730.61	739.18	728.61	718.61	PVC
MW-CL-18I[c]	2	739.06	680.49	739.06	678.49	668.49	PVC
MW-CL-19S[c]	2	726.2	712.64	726.2	710.64	700.64	PVC
MW-CL-20S[c]	2	731.56	725.07	731.56	723.07	713.07	PVC
MW-CL-21S[c]	2	-	-	738.5	718.4	-	-
MW-CL-22S[c]	2	-	-	739.04	706.3	-	-
MW-1[c]	-	721.04	-	-	-	-	-
MW-2[c]	-	726.39	-	-	-	-	-
MW-3	-	725.92	-	-	-	-	-
MW-4	-	742.06	-	-	-	-	-
MW-5	-	737.42	-	-	-	-	-
MW-6	-	742.33	-	-	-	-	-
MW-7	-	741.00	-	-	-	-	-
B-1	-	740.92	-	-	-	-	-
B-2	-	739.55	-	-	-	-	-
B-3[c]	-	736.37	-	-	-	-	-

Table 3.6-3 CPS Groundwater Well and Piezometer Details (Sheet 2 of 2)

Well	Well Diameter[a]	Elevations (feet MSL)					
		Top of Casing	Top of Filter[b]	Top of Screen[b]	Bottom of Screen[b]	Bottom of Filter[b]	Well Construction Material
MW-CL-1	-	-	-	-	-	-	-
MW-CL-2	-	-	-	-	-	-	-
TW-CL-23	1	735.66	-	735.2	725.45	-	PVC
TW-CL-24	1	736.02	-	734.69	725.19	-	PVC
TW-CL-25	1	735.56	-	730.31	720.31	-	PVC
TW-CL-26	1	735.04	-	730.12	720.12	-	PVC
TW-CL-27	1	736.59	-	731.55	721.55	-	PVC
TW-CL-28	1	736.68	-	735.3	725.3	-	PVC
TW-CL-29	1	735.41	-	735.17	725.17	-	PVC
TW-CL-30	1	707.14	-	706.51	702.01	-	PVC
TW-CL-31	1	704.42	-	703.49	701.24	-	PVC
TW-CL-32	1	711.06	-	710.32	705.85	-	PVC

a. Measured in inches.

b. Approximate measurement.

c. Monitoring well/piezometer is included in the RGPP.

Dashed cells indicate data were not reported.

Table 3.6-4a CPS Yearly Surface Water Withdrawal Summary

Year		2018	2019	2020	2021	2022	2018-2022
Monthly Maximum	MGM	28,975.82	28,975.82	28,975.82	28,975.82	28,975.82	28,975.82
	gpm_a	649,100	649,100	649,100	649,100	649,100	649,100
Monthly Average	MGM	23,273.63	21,795.60	24,118.40	22,448.94	24,477.96	23,222.91
	gpm_a	531,352	497,454	548,978	512,683	558,367	529,767
Monthly Minimum	MGM	11,801.99	12,053.94	20,193.05	7,822.94	19,496.74	7,822.94
	gpm_a	264,382	270,025	482,900	175,245	482,900	175,245
Yearly Total	MGY	279,284	261,547	289,421	269,387	293,736	278,675
	MGD	765.16	716.57	790.77	738.05	804.75	763.06

MGY - millions of gallons per year
MGD - millions of gallons per day
MGM - millions of gallons per month
gpm_a - gallons per minute for the month

Table 3.6-4b CPS Monthly Surface Water Withdrawal Summary (Sheet 1 of 2)

Month	Intake (MGM)	Total (gpm_a)
January 2018	21,598.44	483,836
February 2018	19,496.74	483,550
March 2018	21,600.61	483,885
April 2018	20,889.36	483,550
May 2018	11,801.99	264,382
June 2018	28,041.12	649,100
July 2018	28,975.82	649,100
August 2018	28,975.82	649,100
September 2018	28,041.12	649,100
October 2018	27,378.27	613,313
November 2018	20,898.56	483,763
December 2018	21,585.67	483,550
January 2019	21,585.67	483,550
February 2019	19,496.74	483,550
March 2019	21,556.66	482,900
April 2019	20,945.92	484,859
May 2019	23,057.94	516,531
June 2019	27,949.78	646,986
July 2019	28,975.82	649,100
August 2019	28,029.34	627,897
September 2019	15,391.36	356,281
October 2019	12,053.94	270,025
November 2019	20,918.37	484,222
December 2019	21,585.67	483,550
January 2020	21,585.67	483,550
February 2020	20,193.05	483,550
March 2020	21,556.66	482,900
April 2020	20,889.36	483,550
May 2020	23,962.33	536,791
June 2020	28,041.12	649,100
July 2020	28,975.82	649,100

Table 3.6-4b CPS Monthly Surface Water Withdrawal Summary (Sheet 2 of 2)

Month	Intake (MGM)	Total (gpm_a)
August 2020	28,975.82	649,100
September 2020	28,041.12	649,100
October 2020	24,695.65	553,218
November 2020	20,918.37	484,222
December 2020	21,585.81	483,553
January 2021	21,585.67	483,550
February 2021	19,496.74	483,550
March 2021	21,556.66	482,900
April 2021	21,032.70	486,868
May 2021	24,657.65	552,367
June 2021	28,041.12	649,100
July 2021	28,975.82	649,100
August 2021	28,975.82	649,100
September 2021	24,634.79	570,250
October 2021	7,822.94	175,245
November 2021	21,021.71	486,614
December 2021	21,585.67	483,550
January 2022	21,585.67	483,550
February 2022	19,496.74	483,550
March 2022	21,556.66	482,900
April 2022	20,889.36	483,550
May 2022	26,441.21	592,321
June 2022	28,041.12	649,100
July 2022	28,975.82	649,100
August 2022	28,975.82	649,100
September 2022	28,041.12	649,100
October 2022	26,665.81	597,352
November 2022	21,480.53	497,235
December 2022	21,585.67	483,550

MGM - millions of gallons per month
gpm_a - gallons per minute for the month

Table 3.6-5 Surface Water Usage Summary in MGD, 2015

Category	DeWitt County	Piatt County
Public Supply	0.00	0.00
Domestic, Self-Supplied	0.00	0.00
Industrial, Self-Supplied	0.00	0.00
Irrigation	0.02	0.00
Livestock	0.00	0.00
Aquaculture	0.00	0.00
Mining	0.00	0.00
Power Generation (Thermoelectric)	751.81	0.00
Total	751.83	0.00

(USGS 2018)

Table 3.6-6 Groundwater Usage Summary in MGD, 2015

Category	DeWitt County	Piatt County
Public Supply	1.31	1.12
Domestic, Self-Supplied	0.42	0.36
Industrial, Self-Supplied	0.00	3.36
Irrigation	0.06	0.30
Livestock	0.21	0.03
Aquaculture	0.00	0.00
Mining	0.50	0.00
Power Generation (Thermoelectric)	0.00	0.00
Total	2.50	5.17

(USGS 2018)

Table 3.6-7 Offsite Registered Water Wells within 2 Miles of CPS

ISGS Well No.	Distance[(a)] (miles)	Well Depth (feet)	Use Description	Formation Name
120392158300	0.9	31	Water Well	Sand
120392104500	1.0	86	Water Well	Gravel
120392176300	1.0	52	Water Well	Sand & gravel
120390023600	1.0	60	Water Well	Gravel
120392157400	1.2	220	Water Well	Gravel
120392187100	1.2	83	Water Well	Sand & gravel
120392159600	1.3	51	Water Well	Sand
120392180600	1.7	100	Water Well	Gravel
120392092500	1.7	67	Water Well	Sand
120392148700	1.7	75	Water Well	Gravel
120390051200	1.7	81	Water Well	-
120392093100	1.7	352	Water Well	Sand
120392193900	1.8	78	Water Well	Gravel
120392092100	1.8	81	Water Well	Sand
120392119500	1.8	67	Water Well	Sand
120392147000	1.9	72	Water Well	Sand
120390023700	1.9	52	Water Well	Sand & gravel
120392095200	2.0	340	Water Well	-
120392116400	2.0	340	Water Well	Sand w/gravel

(ISGS 2022)

a. Distance is from the CPS center point and rounded to the nearest tenth of a mile. Wells listed are limited to those within a two-mile radius from the site center point.

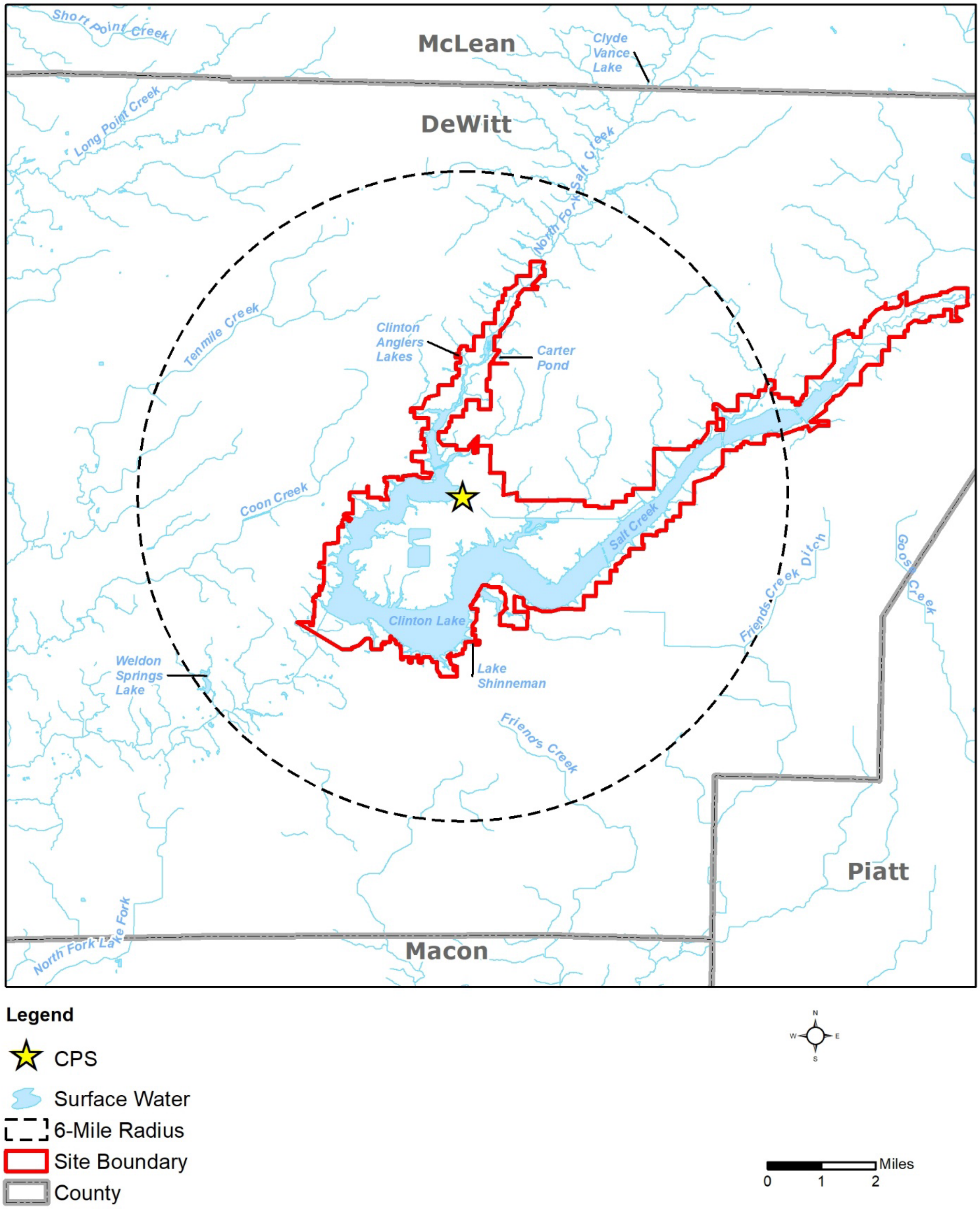


Figure 3.6-1 Vicinity Hydrological Features

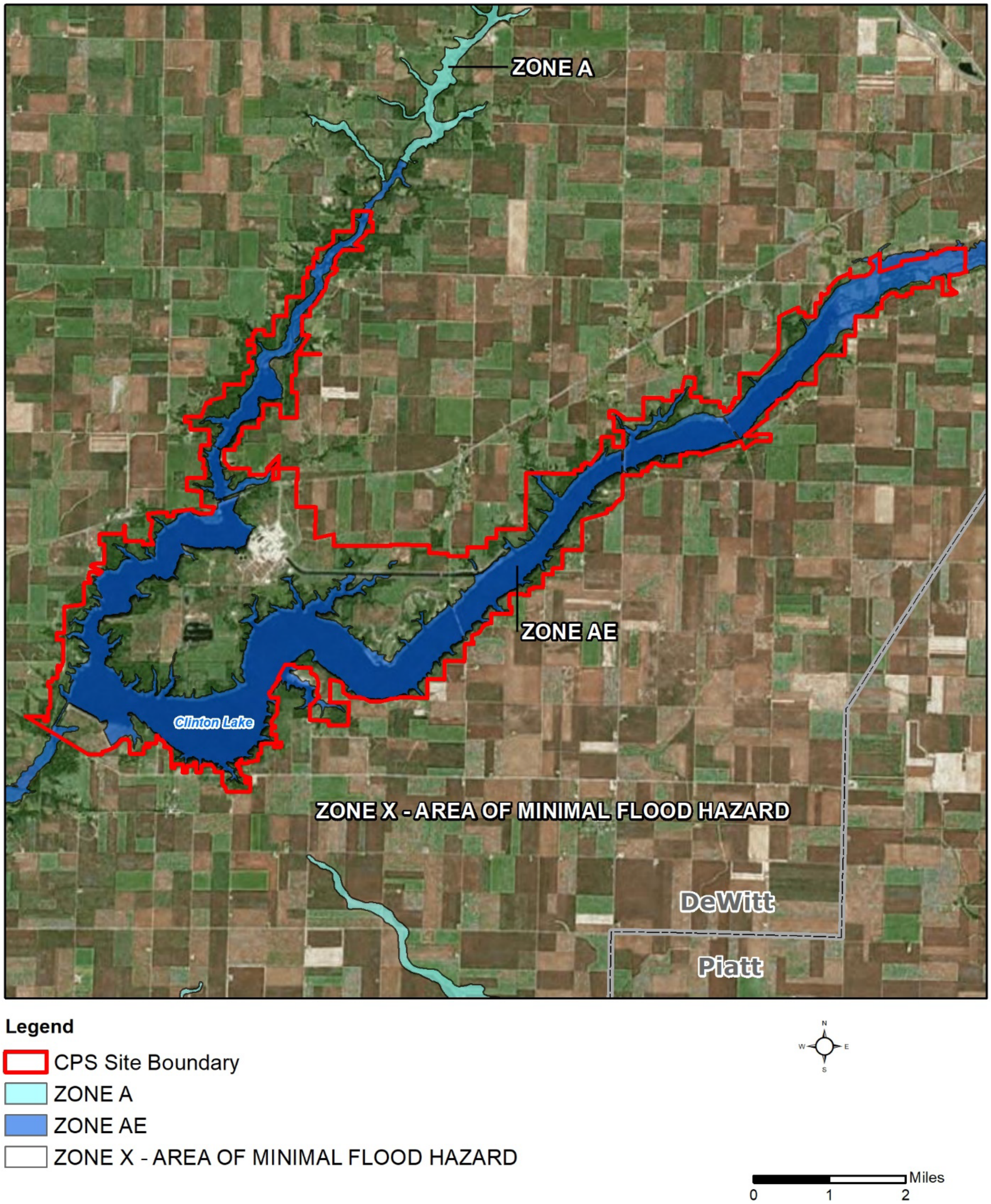


Figure 3.6-2 FEMA Floodplain Zones at CPS

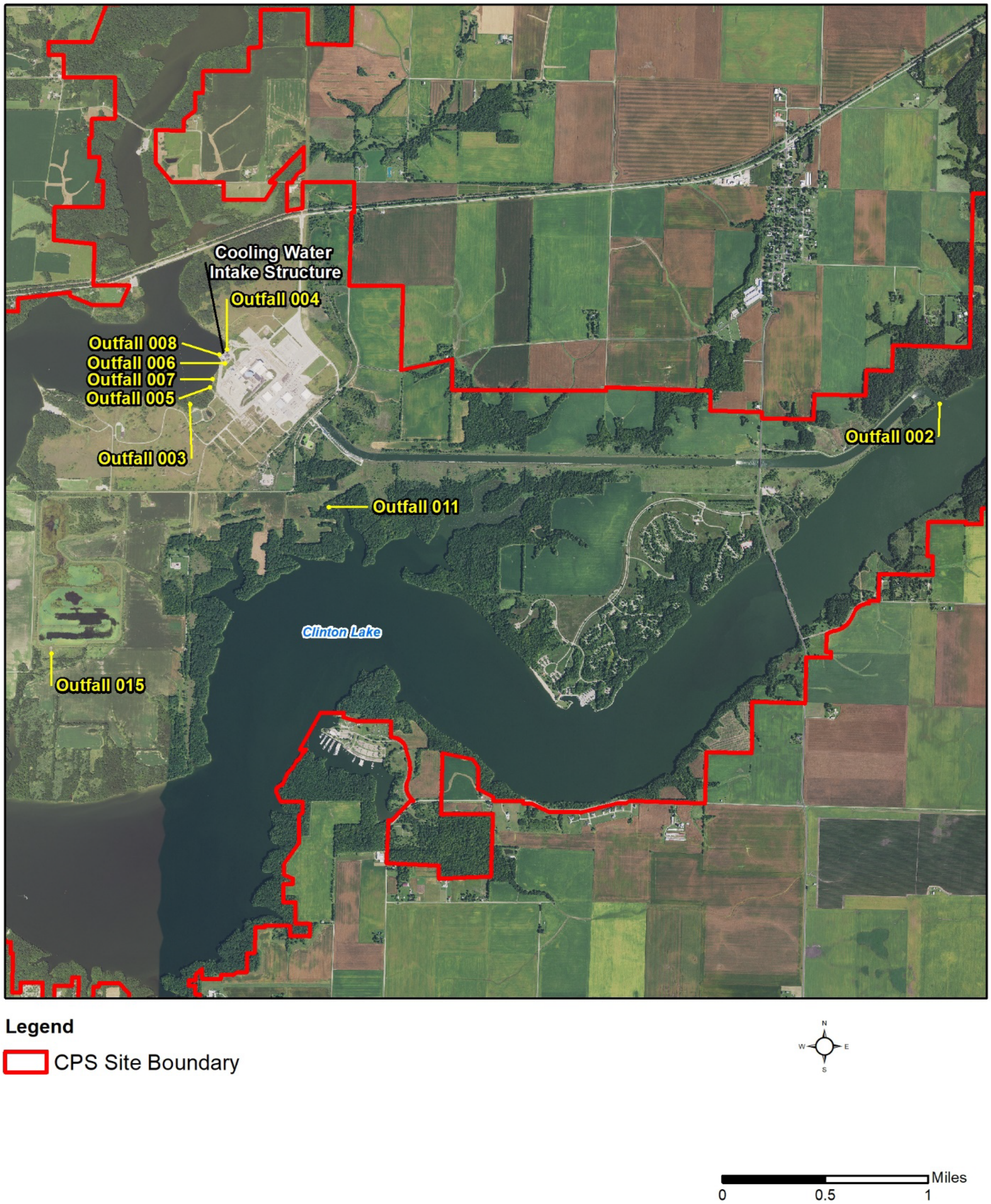


Figure 3.6-3 NPDES Outfalls

Figure 3.6-4 Average Discharge Temperatures

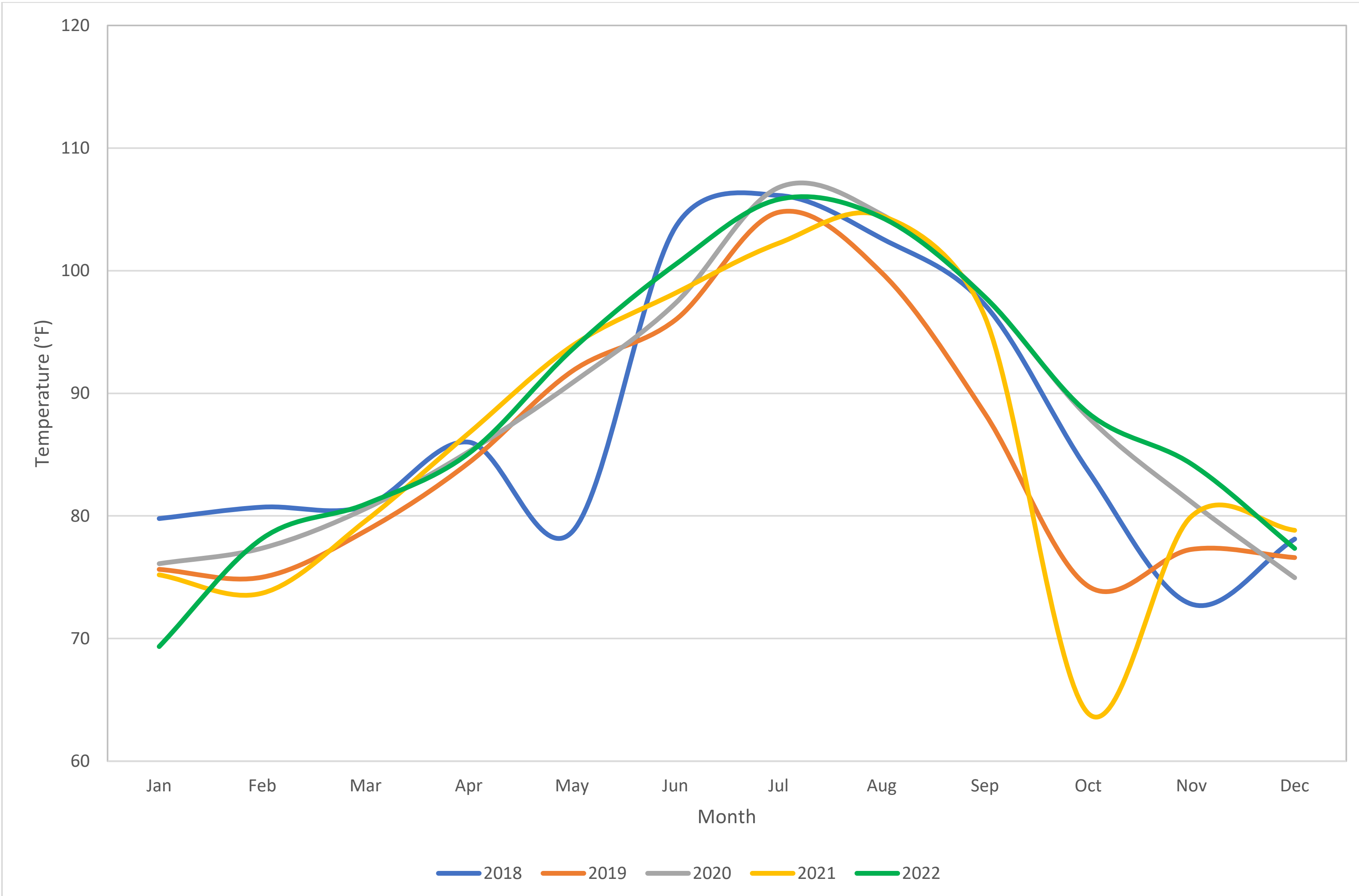


Figure 3.6-5 Outfall 002 Average Discharge Temperatures

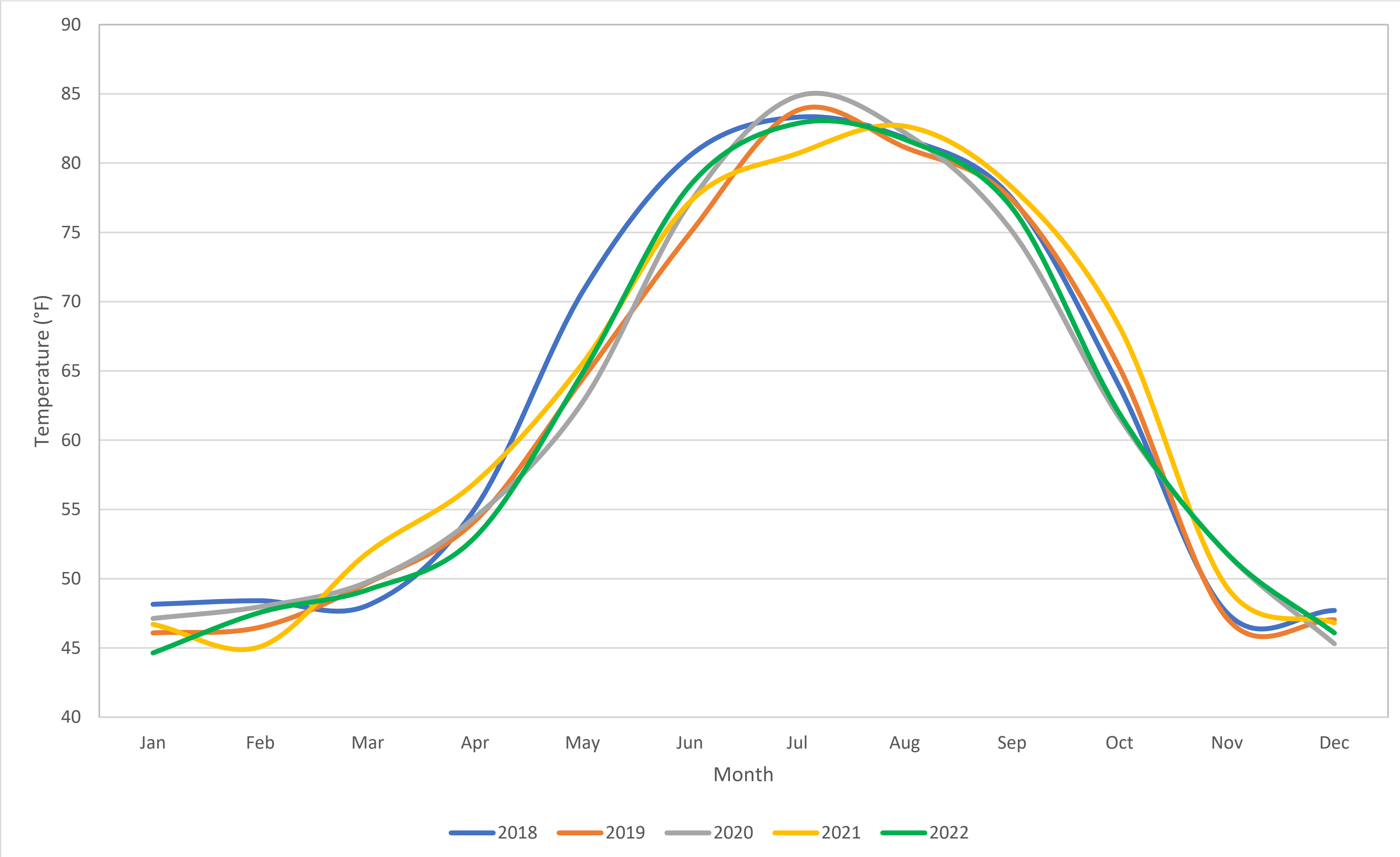


Figure 3.6-6 Average Intake Temperatures

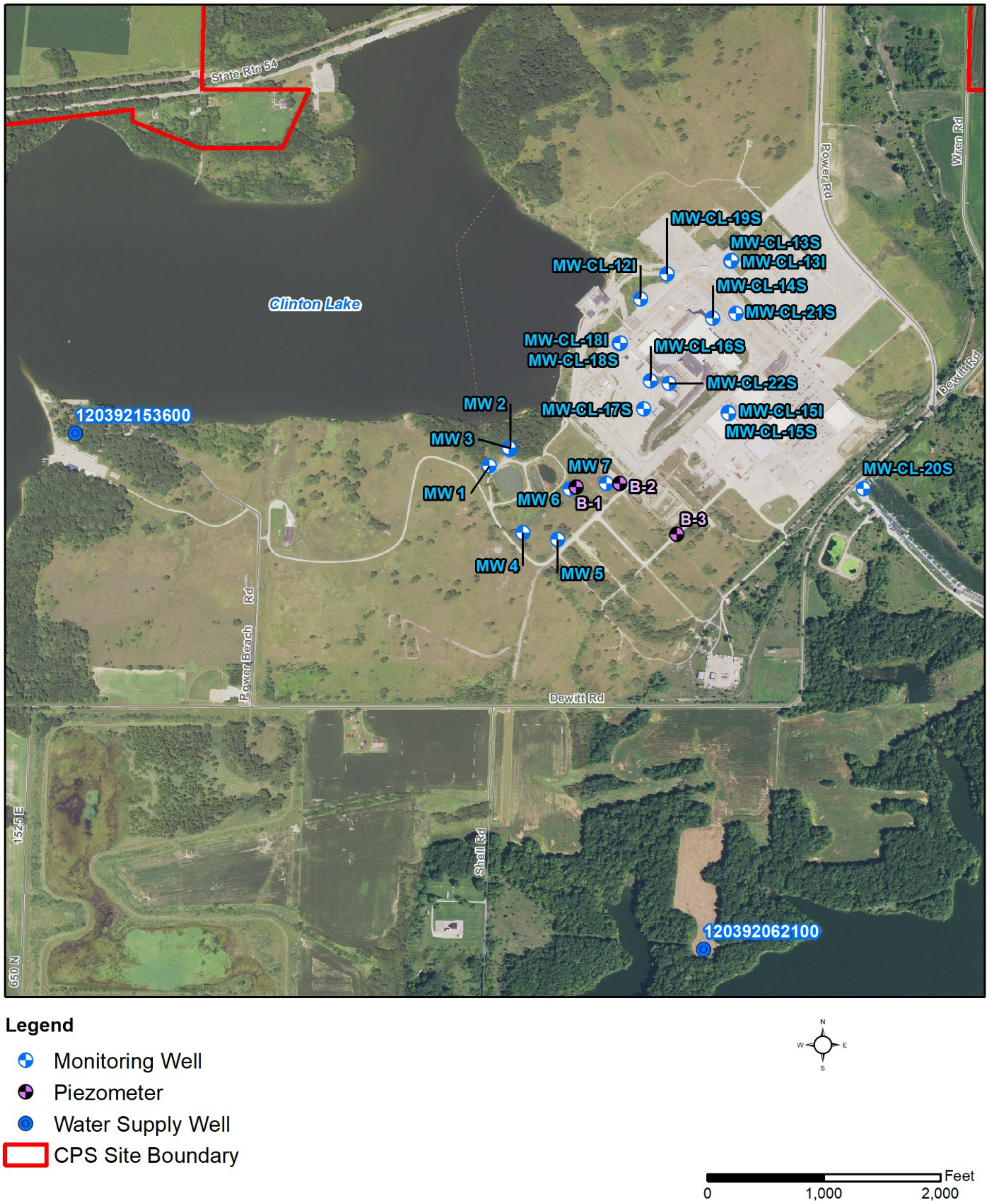


Figure 3.6-7 Onsite Wells

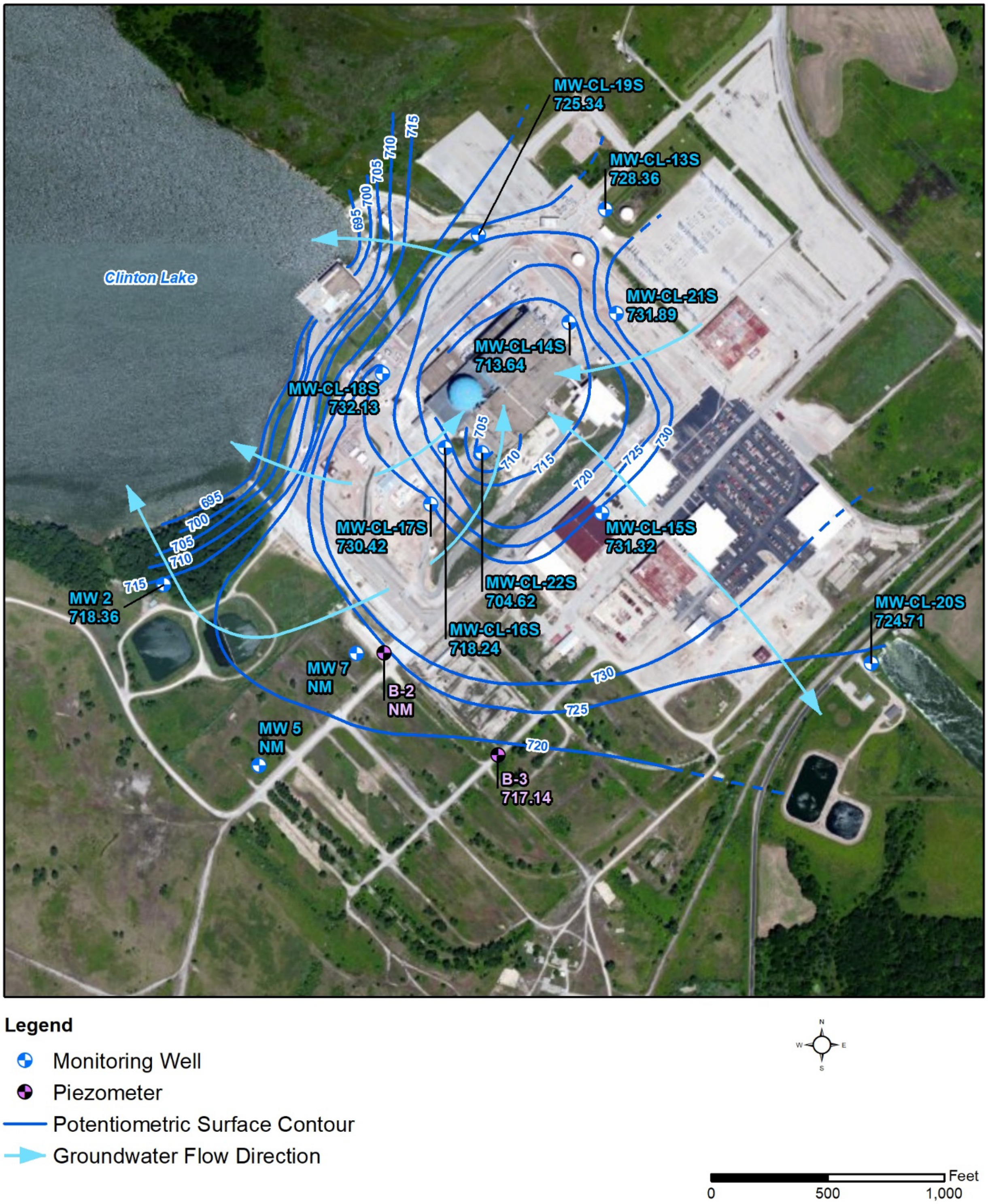


Figure 3.6-8 Shallow Groundwater Zone Potentiometric Map, May 2018

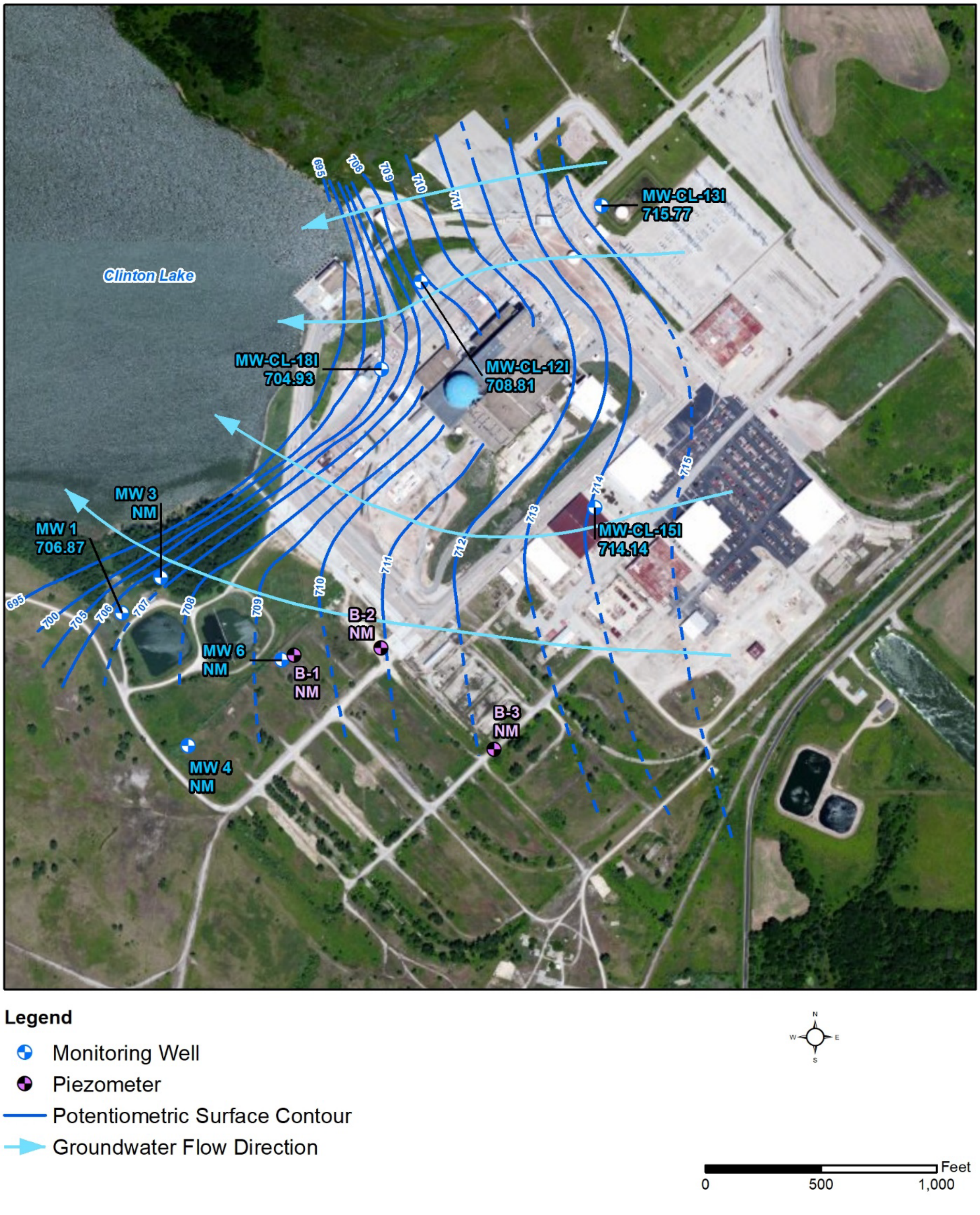


Figure 3.6-9 Intermediate Groundwater Zone Potentiometric Map, May 2018

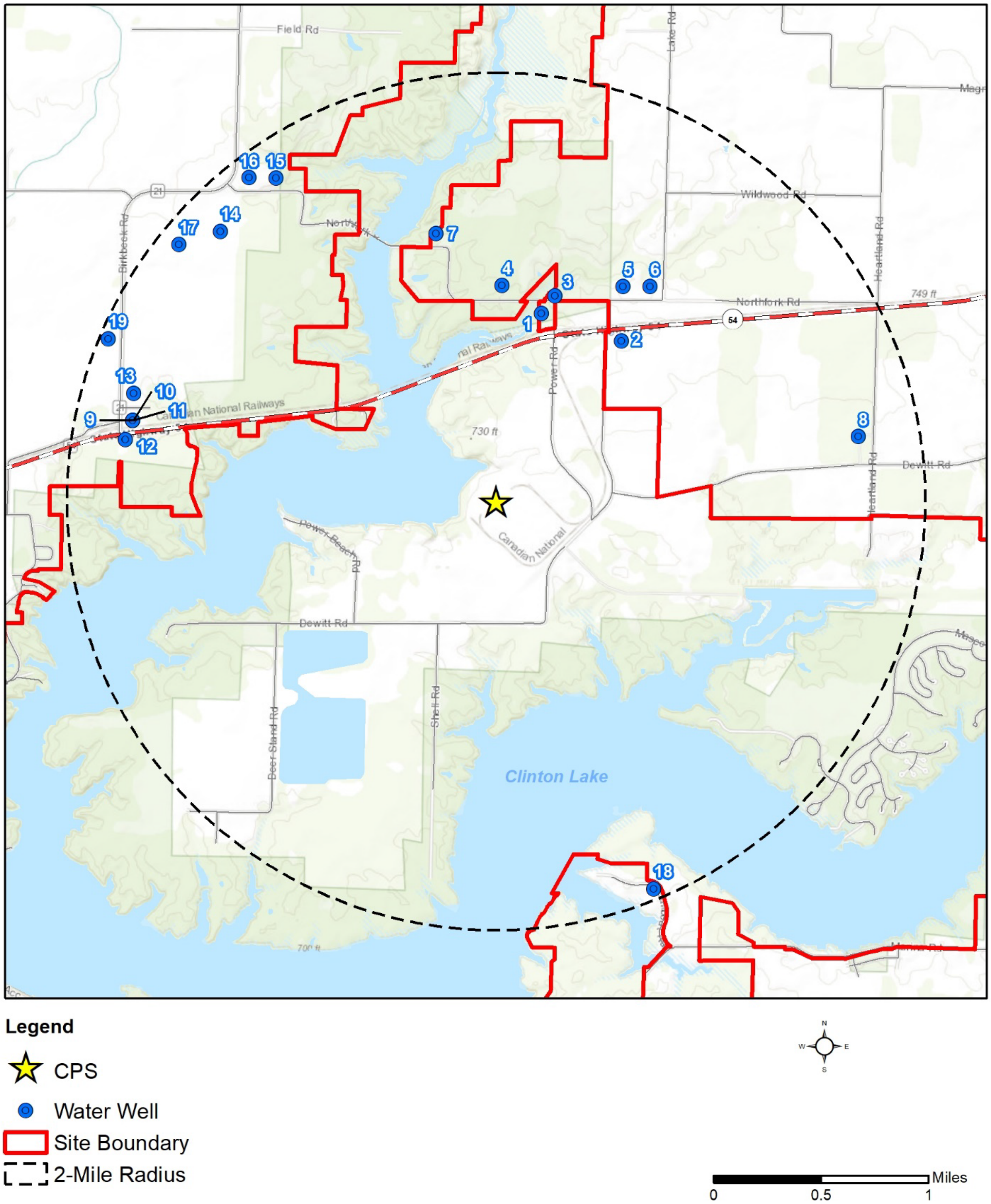


Figure 3.6-10 Offsite Registered Water Wells Within 2 Miles of CPS Center Point

3.7 Ecological Resources

Regional ecology is greatly influenced by the geomorphic and physiographic characteristics of the region. Soils determine the basic fertility of the region, which in turn determines the types of plants that may grow there. The plants that are present greatly influence the types and number of animals that reside in the region. Soil types also greatly influence the basic fertility of aquatic ecosystems and the species present. Climatological factors such as temperature, day length, and precipitation further define the plants and animals that may live in a locale.

This section details the ecological resources of the CPS site, in-scope transmission lines, and the surrounding landscape within the site vicinity.

3.7.1 Aquatic Communities

This section describes the aquatic environment and biota near the CPS site and other areas potentially affected by the continued operation of CPS. It includes a description of the aquatic ecosystems at or near the site, a description of representative important species that are present or are expected to occur, and the location of state parks, critical habitats, or other areas carrying special designations.

The CPS site is situated on a peninsula of Clinton Lake, between the Salt Creek North Fork arm and the Salt Creek arm. Clinton Lake was created when the Illinois Power Company (IPC) erected a dam on the main stem of Salt Creek, just northwest of the community of Lane in 1977, and filled the lake in 1978. The earthen dam lies approximately 1,200 feet (366 meters) downstream from the confluence of Salt Creek and the Salt Creek North Fork. Salt Creek flows southwesterly, joining the Sangamon River at a point about 53 miles (85 kilometers) west of the site. At a normal pool elevation of 690 feet (210 meters), the lake covers 4,895 acres (1,981 hectares) and extends up Salt Creek to about 12 miles (19 kilometers) from the dam and up the Salt Creek North Fork about 7 miles (11 kilometers) from the dam. The CPS unit withdraws cooling water from the North Fork arm and returns it to the Salt Creek arm. This results in a circulation between the two locations whenever the inflow into the North Fork arm is less than the intake demands for the CPS unit's once-through cooling system. The watershed above Clinton Lake drains 296 square miles (476 square kilometers) of predominately agricultural fields with very little relief. Pursuant to the CPS NPDES permit, IEPA currently requires a minimum release of 0.14 cubic meters (m^3) per second (5 cfs) from the Clinton Lake Dam. (EGC 2006).

3.7.1.1 Clinton Lake

Clinton Lake is the largest and most important aquatic resource in the vicinity of the CPS site. As stated above, the 4,895-acre (1,981-hectare) reservoir was filled in 1978, creating a lake environment where there once were two free-flowing streams. The earthen dam constructed across Salt Creek created the reservoir. The reservoir has no fish passage facilities and restricts upstream movement of fish past the dam. The deepest region of the lake is near the dam (approximately 40 feet [13 meters]), but the average water depth is approximately 15 feet (5 meters). The CPS site is located approximately 3 miles (5 kilometers) northeast of the dam between the North Fork of Salt Creek and Salt Creek arms of the lake. (EGC 2006).

The lake is the main attraction for the Clinton Lake State Recreation Area, a 9,300 acre (3,764-hectare) facility located 3 miles (5 kilometers) east of Clinton, Illinois. The park land is owned by CEG (previously AmerGen Energy Company, LLC) the owner and operator of the CPS. Since 1978, the State of Illinois has operated the park through a lease agreement with the utility company. People use the park's lake, marsh, and riverine habitats for boating, swimming, and recreational fishing. (IDNR 2022c)

Besides the lake, other important aquatic habitats near the CPS site include portions of Tenmile Creek and Salt Creek, Weldon Springs State Recreation Area, and several small wetland areas. Illinois designates some environmentally sensitive areas, such as Illinois Natural Areas, and provides varying degrees of protection under the jurisdiction of the Illinois Nature Preserves Commission. There are two of these environmentally sensitive areas near the CPS site. The first includes a portion of Tenmile Creek west of the city of Clinton and approximately 8 kilometers (5 miles) from the site. It is designated as critical habitat (i.e., medium gradient creek) by the IDNR and as a unique aquatic resource by the IEPA (EGC 2006).

The second environmentally sensitive area is along Salt Creek, approximately 3 miles (5 kilometers) from the CPS site. Weldon Springs State Recreation Area is located southeast of the city of Clinton, approximately 6 miles (10 kilometers) from the CPS site. The area includes an 28-acre (11-hectare) spring-fed lake, as well as pond, stream, marsh, forested wetland, and riparian areas. Several small wetland areas, generally associated with small tributaries to Salt Creek and the North Fork of Salt Creek, are present within 6 miles (10 kilometers) of the CPS site and along the transmission line ROWs. These wetland areas include forested, shrub-scrub, and emergent vegetation communities. Additionally, four small wetland areas, each less than 1 acre (0.4 hectares), are present on the site. These are open water resources, such as constructed sediment basins, some of which are used by IDNR as fish-rearing ponds. (EGC 2006)

3.7.1.2 Aquatic Resources of Clinton Lake

Phytoplankton Communities

Surveys of the phytoplankton community in Clinton Lake were conducted from 1983 to 1991 as part of the CPS Environmental Monitoring Program (EMP). The most recent data from this program, collected in 1991, indicates that the average density of phytoplankton in Clinton Lake was approximately 8.7 million per liter. Fifty-four taxa of phytoplankton were collected, with a Shannon diversity index of 3.1. The most abundant taxa were members of the *Stephanodiscus* and *Chlamydomonas genera*, and three species including *Melosira distans, Actinastrum hantzschii,* and *Schizothrix calcicole.* Table 3.7-1 provides a list of phytoplankton observed in Clinton Lake.

Zooplankton Communities

The zooplankton community in Clinton Lake was most recently surveyed in 1991 as part of the Clinton Power Station EMP. In 1991, Clinton Lake had approximately 186,000 zooplankton per cubic meter and 43 zooplankton taxa with a Shannon diversity index of 3.0. The most abundant taxa collected were from the orders *Cyclopoida, Calanoida,* and *Cladocera* and genera *Brachionus, Keratella, Polyartha, and Synchaeta*. Table 3.7-1 provides a list of zooplankton observed in Clinton Lake.

Benthic Macroinvertebrates

The benthic invertebrate community in the vicinity of CPS was surveyed from 1972 through 1991 as part of the Clinton Power Station EMP. In the 1992 CPS Biological Report, benthic macroinvertebrate data from Clinton Lake are compared between preoperational years (1983–1986) and operational years (1987–1991). These data show that in both preoperational and operational years, Oligochaeta, *Chaoboridae*, and *Chironomidae* were the dominant groups of benthic macroinvertebrates collected in Clinton Lake, together accounting for 96.5 percent of benthic fauna collected from 1983 to 1991. The most abundant taxa collected during these years were *Chaoborus punctipennis* (the phantom midge) and *Chironomus* sp. (a species of midge).

The most recent data from the Clinton Lake EMP, collected in 1991, shows a benthic macroinvertebrate density of approximately 1,900 per square meter, composed of 39 taxa with a Shannon diversity index of 3.5. The most abundant taxa collected were members of the *Chaoboridae*, *Chironomidae* and *Naididae* families. Table 3.7-2 provides a list of benthic invertebrates observed in the vicinity of Clinton Lake.

Fish Communities

Numerous fisheries surveys have been conducted in Clinton Lake between 1978 and the present by IDNR, Illinois Natural History Survey, CPS, and consultants for CPS. Table 3.7-3 provides a list of fish species in Clinton Lake. Section 3.7.7.1.4 describes historical fish studies and surveys at CPS, and the general trends in fish community health in Clinton Lake.

The most abundant species collected during the fish surveys conducted in Clinton Lake in 2015 as part of the 316(b) demonstration are American gizzard shad (*Dorosoma cepedianum)*, bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), and common carp.

There are no federally listed fish species found in DeWitt County (USFWS 2022a). The American brook lamprey is listed at the state level as threatened in DeWitt County but has not been observed in Clinton Lake (IDNR 2022d). There are also no commercial fisheries in the vicinity of the CPS site (EGC 2006). However, Clinton Lake does provide sport fishing opportunities, and many of the fish species that inhabit the lake have recreational value and are considered important. These include such species as the channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), bullhead (*Ameiurus* spp.), white bass (*Morone chrysops*), hybrid striped bass (a cross between white and striped bass), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), and other sunfish species (*Lepomis* spp.) (IDNR 2022c). Sauger (*Sander canadensis*) and common carp (*Cyprinus carpio*) are also present, and sometimes caught by sport fishermen. While much of the fishing activity occurs during the warmer months, fishing also attracts people to Clinton Lake in winter. (EGC 2006)

Some recreational fish species are stocked by the IDNR to provide improved fishing opportunities for the public. Stocked species in Clinton Lake include largemouth bass, smallmouth bass, white crappie, walleye, striped bass, and hybrid striped bass. IDNR currently manages and routinely stocks Clinton Lake. In 2015, hybrid striped bass, blacknose crappie, walleye, and blue catfish were stocked. These species either do not reproduce naturally in Clinton Lake, have exhibited poor recruitment (due in part to lack of appropriate spawning and rearing habitat, such as emergent aquatic vegetation), or are still in the process of recovering their population structure as a result of flood events that occurred between 1993 and 1995. Most of the fish are supplied through an offsite IDNR hatchery program, but there is also a limited number of smallmouth bass, walleye, and white crappie produced by IDNR in small ponds located on the CPS site. (EGC 2006)

The Clinton Lake fishery is managed by IDNR. To provide balance between fishing opportunity and fish population structure and abundance, IDNR imposes a minimum length and daily creel limit on some species (IDNR 2022c). Periodic creel surveys are conducted at Clinton Lake by the Illinois Natural History Survey, and the results are provided to IDNR. Various portions of the lake are designated as no-wake, electric motor only, or no-boat areas for safety and security reasons. Areas closed to public access in 2004 included the water-intake area for CPS, the spillway, and the dam areas east of the spillway, and the water surface of the discharge canal (EGC 2006).

Mussels and Other Shellfish

Freshwater mussel studies have not been conducted at Clinton Lake because they were not required by any of the regulatory agencies in the operating permit. However, biofouling organisms have been noted in diver inspections in CPS Unit 1 SX. During the diver inspections of the sediments about a half dozen large freshwater mussels (family *Unionidae*) were collected from the SX Basin. Relic fingernail clams (*Sphaeriidae*) and Asian clams (*Corbicula)* were also noted during the diver's inspection at CPS.

Freshwater mussels were observed in Salt Creek below the Clinton Lake spillway during the 2015 fisheries and thermal surveys conducted at Clinton Lake as part of a 316(a) Demonstration Report. A mussel survey was not conducted, but two species of *Unionidae* mussels were observed on the shoreline. The two mussel species that were observed included the plain pocketbook (*Lampsilis cardium)* and the white heelsplitter (*Lasmigona omplanata*).

Several specimens of each species were observed with some of the individuals being very large.

Corbicula are special interest because of problems they can potentially cause to the condensers, heat exchangers, strainers, or the fire protection water system at CPS. *Corbicula* were first collected in Clinton Lake during the EMP in May of 1986, and their greatest density in that program was recorded in May 1988 within the discharge canal. In the 2003 diver's inspection of the SX basin, 38 relic *Corbicula* shells were observed in collected sediments (SEA 2003). Samples for *Corbicula* were also collected in February and March 2007 in the main Unit 1 screen house basin. Thirty-one live *Corbicula* and 28 relic shells were collected on the pump sides of the traveling screens. No *Corbicula* were collected on the lake side of the traveling screens or in the SX basin.

3.7.2 Terrestrial and Wetland Communities

All of the CPS site has been graded or otherwise developed for operation of the station. Consequently, most of the area at the CPS site (including permanent structures and laydown areas) consists of weedy habitats, cleared areas, impervious surfaces, existing structures, dirt roads, etc. A small amount of forest habitat is located within the footprint of the power block, and there are four minor herbaceous wetlands (less than 0.4 hectares) within the CPS site boundary, nuclear unit. Generally, wildlife species found on the CPS site are representative of those commonly found in the central Illinois region. (EGC 2006)

3.7.2.1 Physiographic Province

The CPS site lies within the Central Lowlands Physiographic Province which is characterized by a low-relief surface formed by glacial till, outwash plains, and glacial lake plains. The Central Lowland province, the largest physiographic province, covers an area of about 585,000 miles which extends from western New York to North Dakota and south to Texas. The majority of the province is bounded by higher relief, and elevations in the region are 2,000 feet or less. The province is part of the Interior Plains division of the United States and characteristic features of the Central Lowland province are flat lands with geomorphic remnants of glaciation. The glacial materials overlay consolidated Paleozoic-age materials throughout most of the province. Aquifers in the Central Lowlands Province occur in unconsolidated sand and gravel of the Quaternary age and consolidated sandstone, limestone, and dolomite of the Paleozoic age. (NPS 2017).

3.7.2.2 Ecoregion

CPS is situated within the Illinois/Indiana Plains ecoregion, which falls within the larger Central Corn Belt ecoregion (EPA Level III 54 ecoregion). The vast, glaciated, flat to rolling plains of the Illinois/Indiana Plains Ecoregion are characterized by dark, very fertile soils that developed under tall-grass prairie; in addition, marshes and wet prairies naturally occurred in poorly drained areas, and forests grew on concentric moraines and floodplains. The soils of the Illinois/Indiana Prairies are typically rich in organic material, and developed from loess, glacial drift, or lacustrine sediments. At the time of settlement, poorly drained land, ponds, and swamps were common. Poor drainage was especially pronounced in the youngest, most recently glaciated parts of the Wisconsinan till plain. However, even on much older, more dissected till plains in the west where drainage systems are comparatively well integrated, many lowlands between moraines were naturally wet or seasonally covered by standing water. Subsequently, extensive parts of the Illinoian and Wisconsinan till plains have been tiled, ditched, and tied into the existing drainage system to make the land more suitable for cropland and settlement. In the process, marshes and pothole lakes were drained, and once abundant waterfowl were displaced. Nearly all of the original prairies have now been replaced by agriculture. Corn and soybeans are the main crops; cattle, sheep, poultry, and hogs are also raised. Agriculture has affected stream chemistry, turbidity, and habitat. (Woods et al. 2006)

3.7.2.3 Terrestrial Vegetation

A variety of vegetation communities in various stages of ecological succession can be found near the vicinity of the CPS site and along the transmission line ROWs. Agriculture (including hay, row crops, and small grains) is the predominant land use within 6 miles of the site. Open lands that are not used for active agricultural purposes are commonly used as pasture. Herbaceous plant species commonly found in upland pasture and open field habitats include common ragweed (*Ambrosia artemisiifolia*), Kentucky bluegrass (*Poa pratensis*), red sorrel (*Rumex acetosella*), Japanese brome (*Bromus japonicus*), timothy (*Phleum pratense*), and common yarrow (*Achillea millefolium*). Shrub species include multiflora rose (*Rosa multiflora*), blackberry (*Rubus* spp.), and hawthorn (*Crataegus* spp.). Open field habitats dominate the landscape at and adjacent to the CPS site (EGC 2006).

Upland forest communities in the vicinity of the CPS site harbor overstory and herbaceous species that are common and typical of the region. Herbaceous species include multiflora rose, may apple (*Podophyllum peltatum*), trillium (*Trillium* spp.), goldenrod (*Solidago* spp.), aster (members of the family Asteraceae), and Jack-in-the-pulpit (*Arisaema triphyllum*). Overstory species include several species of oak (*Quercus* spp.) and elm (*Ulmus* spp.), black cherry (*Prunus serotina*), shagbark hickory (*Carya ovata*), black walnut (*Juglans nigra*), hackberry (*Celtis* spp.), honeylocust (*Gleditsia triacanthos*), and red mulberry (*Morus rubra*). (EGC 2006).

3.7.2.4 Wetlands

Wetlands are defined as areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally, include swamps, marshes, bogs, and similar areas (USACE 1999). The USFWS maintains the National Wetlands Inventory (NWI), which integrates digital map data along with other resource information to produce current information on the status, extent, characteristics, and functions of wetland, riparian, and deep-water habitats in the United States. Based on a review of USFWS NWI maps of the site, there are approximately 5,196 acres of wetlands within a 6-mile radius of CPS, composed of the following types (Figure 3.7-2):

- Freshwater emergent wetlands covering approximately 63 acres (1.22 percent of total wetland habitat)
- Freshwater forested/shrub wetlands covering approximately 304 acres (5.86 percent of total wetland habitat)
- Freshwater ponds covering approximately 91 acres (1.75 percent of total wetland habitat)
- Lakes covering approximately 4,450 acres (85.64 percent of total wetland habitat)
- Riverine waters covering approximately 288 acres (5.53 percent of total wetland habitat)

The CPS property encompasses most of Clinton Lake. Based on the NWI data (USFWS 2022b), a total of 5,210 acres of wetlands, lakes, ponds, and riverine waters are mapped on the CPS site (Figure 3.7-2). Based on the NWI data, the following wetland water types are located on the CPS site:

- Freshwater emergent wetlands covering approximately 45 acres (0.86 percent of total wetland habitat)
- Freshwater forested/shrub wetlands covering approximately 231 acres (4.43 percent of total wetland habitat)
- Freshwater ponds covering approximately 28 acres (0.54 percent of total wetland habitat)
- Lakes covering approximately 4,837 acres (92.84 percent of total wetland habitat)
- Riverine waters covering approximately 69 acres (1.33 percent of total wetland habitat)

Two wetland delineation studies were performed at the CPS site to determine the presence, extent and quality of wetlands or waters of the United States. One was conducted in 2014 for an approximately 32-acre tract as part of a gun range project and the second in 2018 for a 9.37-acre tract of land for the installation of cooling towers. Two wetland areas (Area 1 and Area 2) were delineated during the 2014 study. Area 1 (~0.48 acres) was located in the southwestern portion of the subject property and consisted of an isolated wetland. Area 2 (~0.91 acres) was located in the central portion of the subject property and consisted of an active channel and wetland areas. Pipes discharging water from other portions of the surrounding property were observed throughout Area 1 and Area 2. Area 1 was determined to be an isolated regulatory wetland not regulated by the USACE, while Area 2 was determined to be a wetland subject to USACE jurisdiction. Two drainages ditches (~0.31 acres and ~0.07 acres) were identified during the 2018 study. Both the drainage ditches contained wetland vegetation and met the three wetland criteria; however, both features were identified to be manmade and were excavated in association with the construction of the discharge flume.

CEG maintains an Environmental Evaluations procedure that provides guidance to environmental personnel on performing evaluations to identify environmental and regulatory impacts of any proposed activities. This procedure also includes guidance for wetlands.

3.7.2.5 Terrestrial Animal Communities

Terrestrial fauna species potentially to be observed within a 6-mile radius of the operating station are listed in Table 3.7-3. Wildlife species found in the vicinity of the CPS site and along the transmission line ROWs are representative of those commonly found in the central Illinois region. A number of mammal species have been identified, including deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), various shrew species (including shorttail and least shrews [*Blarina brevicauda* and *Cryptotis parva*, respectively]), white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), beaver (*Castor canadensis*), coyote (*Canis latrans*), fox (*Vulpes fulva* or *Urocyon cinereoargenteus*), muskrat (*Ondatra zibethicus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), and thirteen-lined ground squirrel (*Citellus tridecemlineatus*). Wildlife diversity is highest in the forest communities (EGC 2006).

Habitats located in the vicinity of the CPS site and along the transmission line ROWs are suitable for a variety of migrating songbirds, shorebirds, waterfowl, and raptors. Ninety-six avian species have been identified in the vicinity during spring and fall. Of the 96 species, 36 are summer residents, 29 are migratory, 28 are permanent residents, and 3 are winter residents (EGC 2006). Common terrestrial bird species include red-winged blackbird (*Agelaius phoeniceus*), common grackle (*Quiscalus quiscula*), northern cardinal (*Cardinalis cardinalis*), redheaded woodpecker (*Melanerpes erythrocephalus*), various species of sparrows, dark-eyed junco (*Junco hyemalis*), black-capped chickadee (*Poecile atricapilla*), blue jay (*Cyanocitta cristata*), mourning dove (*Zenaida macroura*), northern flicker (*Colaptes auratus*), downy woodpecker (*Picoides pubescens*), American crow (*Corvus brachyrhynchos*), and starling (*Sturnus vulgaris*). The most common game birds include ring-necked pheasant *(Phasianus colchicus*), northern bobwhite (*Colinus virginianus*), and wild turkey (*Meleagris gallopavo*). A variety of rare terrestrial bird species have been documented in the vicinity, including the gyrfalcon (*Falco rusticolus*) and prairie falcon (*Falco mexicanus*) near Clinton Lake. Clinton Lake and other water bodies located within the vicinity provide suitable habitat for waterfowl, including American widgeon (*Anas americana*), American black duck (*Anas rubripes*), blue-winged teal (*Anas discors*), coot (*Fulica americana*), lesser scaup (*Aythya affinis*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), redhead (*Aythya americana*), wood duck (*Aix sponsa*), and Canada goose (*Branta canadensis*). Common migratory shorebirds include a variety of sandpipers and herons. Clinton Lake also supports loons, grebes, and wintering gulls (EGC 2006).

Reptiles and amphibians that commonly occur in the vicinity of the CPS site include various species of frogs, salamanders, snakes, and turtles, most of which are commonly found throughout the region (EGC 2006).

3.7.2.6 Transmission Lines

Physical features (e.g., length, width, route) of each of the in-scope transmission lines are described in Section 2.2.5.1. The transmission corridors are situated within the central lowlands' physiographic province, which is described in Section 3.7.2.1. All in-scope transmission lines are located completely within the CPS site, as shown in Figure 2.2-2.

The in-scope transmission corridors do not cross any state or federal parks or designated critical habitat for protected species. The in-scope transmission line corridors consist primarily of developed land (substation/switchyard, parking lots, etc.); however, some vegetated areas are crossed, consisting of maintained grass, trees, and shrubs. While significant vegetation growth is unlikely due to the industrialized location of the in-scope transmission corridors, the corridors are monitored for vegetation.

The risk of collision with in-scope transmission lines poses a potential threat to avian species. CEG's Avian and Wildlife Management Plan describes the company's practices and measures in the event of observed avian accidents or deaths including collisions with transmission lines.

There are no site-specific procedures regarding maintenance of vegetation under the in-scope transmission lines; however, CEG has undertaken a transmission line ROW grasslands restoration project (described in detail below) with the objective to improve native plant biodiversity and restore native pollinators across an area of approximately 65 acres. This includes spot herbicide treatments, spot mowing of brush, and localized removal of woody brush to prepare the site for the restoration project. There are no site-specific procedures for the application of herbicides used to control vegetation under in-scope transmission lines, although herbicide spot treatments were used as part of a restoration project which is discussed below.

CPS initiated a ROW grassland restoration project including their in-scope transmission lines in 2017. This project's conservation objective was to convert the area underneath the Ameren high power transmission lines to an area that contains grassland plants that attract pollinators and allow native pollinators to create additional habitats. The area under and around the power lines is routinely inspected by Ameren, Pheasants Forever, and site personnel to ensure the area remains in acceptable condition. If any invasive species are identified, the appropriate personnel are notified. Any invasive species would either be mowed or burned depending on the amount and relative location of the species. There is also currently pollinator signage throughout the grassland to indicate to the public that the area is a developing and safe habitat. During site preparation in 2017, the flat areas were seeded with a drill, and the hillsides were hand-broadcast. In preparation for the 2017 plantings, the site was pre-prepared. All woody brush was mowed with a Fecon in fall 2016, and one herbicide treatment was applied in spring 2017 for seeding in early June 2017. Woody species were treated with herbicide spot treatment in summer 2017 to ensure adequate sunlight to the newly established grassland seeds. Spot mowing of brush occurred in March 2019. CPS personnel mowed the site in spring 2020 to remove excess brush. Herbicide was used in 2021 and 2022 for spot treatment on invasive species.

Monitoring of the grasslands was performed routinely by CEG, IDNR and Ameren by going out into the planted grassland area, making observations, and taking pictures of the area. The pictures are used as project data so as to allow CEG, Ameren, and Pheasants Forever to visually observe changes to the grassland over time. Additionally, CEG worked with Monarch Joint Venture to conduct a monitoring project in July 2020.The station and monarch data were submitted to the Integrated Monarch Monitoring Program. Continued monitoring surveys of the ROW have noted the presence of pollinators in all areas of the visible 65 acres. The flowering plants and grasses in the area have attracted a great number of insects including butterflies, skippers, moths, and beetles. Monitoring conducted by Pheasants Forever in 2018 found an abundance of swallowtail butterflies, painted ladies, green bees, bumblebees, monarchs, leafhoppers, skippers, ants, and various beetles. The observations of the grassland post-planting have proven that seeds planted across the 65 acres of the high-power transmission lines have taken well and have even begun to attract pollinators including monarchs, and the planted grasses and flowers have continued to establish and dominate the areas.

3.7.3 Potentially Affected Water Bodies

3.7.3.1 Clinton Lake

As discussed in Section 2.2.3.1, CPS uses Clinton Lake, a man-made, run-of-the-river impoundment of water as its sources of cooling water. Clinton Lake was constructed as a cooling lake as part of the station's cooling system. (IEPA 2021a)

Clinton Lake is a 4,895-acre freshwater lake created by the construction of an earthen dam 1,200 feet downstream of the confluence of Salt Creek and the North Fork of Salt Creek. Clinton Lake is a V-shaped reservoir, with a total of 130 miles of shoreline. The lake's surface elevations can vary from 685.5 feet above MSL in a drought to 697.0 feet above MSL at high water. (IEPA 2021a)

The circulating water system at CPS consists of a cooling lake, CWIS, condensers, and a discharge flume. Cooling water travels through the traveling water screens to a common plenum with the circulating water pumps. Cooling water passes through the station, cooling the condensers for the BWR. The water then reaches a flume which discharges the water to the Salt Creek finger of Clinton Lake. The discharge flume has a bottom width of 120 feet and returns the water from the facility to Clinton Lake. (IEPA 2021a)

As described in Section 2.2.3.1 and shown in Figure 2.2-1, the circulating water system delivers water from the cooling lake to the main condenser and returns it in sufficient quantities to condense the steam exhausted from the main and auxiliary turbines. The cooling lake is designed to dissipate the rejected heat before the water returns to the system intake in the screen house. (EGC 2020a) The cooling lake maintains the temperature of the water entering the circulating water system within the range of 32°F to 95°F. The circulating water system includes a warm water circulation subsystem to maintain a 40°F minimum temperature for the water delivered to the condenser. (EGC 2020a)

The circulating water system consists of the following components: screen house, intake screens, circulating water pumps, pump building, tube side of the main condensers, condenser water box air evacuation subsystem, fill water subsystem, water box drain subsystem and all required piping and valving. (EGC 2020a) The screen house serves as a CWIS to provide a continuous supply of water from Clinton Lake to the Unit 1 reactor and non-contact cooling system. The CWIS was designed with 14 bays for 2 potential operating units, however, 7 bays are unused for Unit 2 (which was never constructed) and are not connected to other bays. Of the remaining 7 bays that supply water to Unit 1, 6 provide cooling water to the circulating water pumps and 1 provides water to the service water pumps. There are 3 circulating water pumps, 2 service water pumps, and 1 standby service water pump in the screen house.

The cooling water is circulated by three one-third capacity motor driven pumps. The design flow per pump is 220,000 gpm (316.8 MGD). As shown on Figure 2.2-1, the average intake cooling water flow is approximately 611,111 gpm (880 MGD). CPS pumps draw water from Clinton Lake at a rate of 35,700 liters per second (566,000 gpm) in the summer and 28,075 liters per second (445,000 gpm) in the winter. The large volume of water withdrawn from Clinton Lake for condenser cooling is returned to the lake. (EGC 2006) While there is no consumptive use of water between intake and discharge, the elevated temperature of the discharged water results in some induced evaporative losses from Clinton Lake. (NRC 2006) Estimates of water consumption due to evaporative loss from cooling towers are not available. The annual discharge flow rate from Clinton Lake into Salt Creek is estimated as 255 cfs or 165 MGD.

CPS cannot operate without the intake and discharge of cooling water, which directly impacts Clinton Lake. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license. The effects of the proposed federal action—the continued operation of CPS, which necessarily involves the removal and discharge of water from Clinton Lake—are therefore shaped by the NPDES permit issued to the station. The current NPDES permit was effective as of April 1, 2020, and modified on May 3, 2021, with an expiration date of March 31, 2025 (Attachment B).

3.7.4 Places and Entities of Special Ecological Interest

Important terrestrial habitats in the vicinity of the CPS site include Clinton Lake State Recreation Area, Weldon Springs State Recreation Area, and wetlands recognized in the NWI Inventory database.

3.7.4.1 Clinton Lake State Recreation Area

Clinton Lake is part of the Clinton Lake State Recreation Area, consisting of approximately 9,300 acres, completely owned by CEG and operated by the IDNR since 1978 via a long-term lease with CEG (formerly AmerGen). Major habitat types of the Clinton Lake State Recreation Area include forest (38 percent of the area), grassland (32 percent), shrubs (21 percent), cropland (6 percent), and wetlands (3 percent). In addition, there are several habitats, including wet meadows, pine forest, and a marsh, which are important for a variety of birds (EGC 2006). The IDNR carries out its programs to improve wildlife habitat (e.g., planting warm season grasses and cool season brood habitat for northern bobwhite [*Colinus virginianus*] and ring-necked pheasant [*Phasianus colchicus*], planting food plots, tree planting, mowing, chemical brush control, maintenance of wood duck nest boxes, etc.) within the recreation area with the permission of CEG. (EGC 2006; IDNR 2022c).

3.7.4.2 Weldon Springs State Recreation Area

Located just southeast of CPS in DeWitt County, Weldon Springs State Park is a 550-acre park for all seasons. Weldon Springs' recreational agenda is among the most comprehensive in the state park system, offering year-round recreational opportunities. The recreational areas offer fishing, boating, picnic areas, camping, hiking, and wildlife viewing. (IDNR 2022e). Woodlands in the recreation area are vegetated predominantly with a variety of oak, hickory (*Carya* spp.), maple *(Acer* spp.), ash (*Fraxinus* spp.), black walnut, sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), and honeylocust. Wetlands include lake, pond, and stream habitats, in addition to marsh, forested wetland, and riparian areas (EGC 2006; IDNR 2022e).

3.7.5 Invasive Species

This section details the aquatic and terrestrial invasive species present in Illinois and discusses those that might occur in the vicinity of the CPS site or in DeWitt County. The University of Georgia's Center for Invasive Species and Ecosystem Health maintains a comprehensive list of invasive species that occur in Illinois. These are discussed below.

CPS has procedures for monitoring and control of invasive species in some areas of its property where conservation projects are being undertaken. These include areas under in-scope transmission lines and the Mascoutin State Recreation Area Park Office, where CPS personnel have undertaken habitat restoration projects to bring back native grasslands for pollinators. These habitat restoration projects have included the removal of identified invasive terrestrial plant species prior to re-seeding areas with native plant seed mixes.

3.7.5.1 Invasive Aquatic Plants

Flowering rush (Butomus umbellatus)

Butomus umbellatus is a perennial which spreads primarily from rhizomes. This aquatic plant invades along the margins of slow-moving waterways. This plant can reach from 1-5 feet (0.3-1.5 meters) in height and can survive in water of up to 9.8 feet (3 meters) deep. It does not tolerate salt water. The leaves are linear, up to 3.2 feet (1 meter) long and triangular and fleshy in cross-section. The leaves may be erect or floating on the surface of the water. Flowering occurs in June to August, when umbels of small, 0.75-1 inch (1.9-2.5 centimeters) wide, pink to white flowers develop. The fruit is beaked, which splits at maturity to release the seeds. The seeds float, which allows them to be easily dispersed by water. This plant spreads mostly from rhizomes and occurs in wet areas with muddy soil, such as freshwater marshlands, lakes, and streams. *Butomus umbellatus* can displace native riparian vegetation. It can form dense stands, which are an obstacle to boat traffic. It is tolerant of a wide range of temperatures, which gives it the potential to invade across much of the United States. *Butomus umbellatus* is native to

Eurasia and was first found in Canada in the late 1800s and in the United States in the early 1900s. (CISEH 2022aa)

Brazilian waterweed (Egeria densa)

Brazilian waterweed is a submersed aquatic plant native to South America and introduced to the United States in the late 1800s as an aquarium plant. Leaves are finely serrated, less than an inch long, and occur in whorls of three to six. Flowers are white, three-petaled, and bloom above the water's surface. It reproduces vegetatively from special double nodes which break away and bud. Brazilian waterweed invades both still and flowing water ecosystems including lakes, ponds, ditches, and rivers. It can form dense stands that crowd out native vegetation and reduce the area's value as fish habitat. It can also interfere with recreational activities such as fishing and swimming. (CISEH 2022ab).

Hydrilla (Hydrilla verticillate)

Hydrilla is a submersed, rooted aquatic plant believed to be native to Asia or Africa. It was first introduced into North America as an aquarium plant in the 1950s. Plants can survive in depths up to 40 feet in water. Leaves are 0.2-0.8 inches long, serrated, and occurred in whorled bunches. The midribs of the leaves are reddish, and their undersides have small, raised teeth. Only individuals with female flowers have been recorded in the United States. The plant reproduces vegetatively from bud-like structures. Hydrilla forms dense mats that can restrict native vegetation, irrigation, recreation, hydroelectric production, and water flow. It can invade most slow-moving or still water systems (CISEH 2022ac).

Purple loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial herb native to Europe and Asia. It was brought to North America in the early 1800s for ornamental and medicinal uses. It is widespread in the United States and throughout Illinois. Purple loosestrife grows in clusters of square woody stems, green to purple in color. Stems can grow up to 3 meters high. Leaves are lance-shaped and stemless, and sometimes covered in fine hair. Flowers are pink to purple-red and grow in long spikes. Purple loosestrife spreads quickly, outcompeting and replacing native grasses and plants which provide food and habitat to wildlife. It forms dense stands which restrict native wetland plants and alters the structure of wetlands (CISEH 2022ad).

Eurasian watermilfoil (Myriophyllum spicatum)

Eurasian watermilfoil is an aquatic plant that has feather-like leaves and can grow between 1 to 3 meters long. Stems of the plant can vary in color between green, brown, or pinkish white. Eurasian watermilfoil can easily be confused with native species with similar appearance. However, it can be distinguished from native species by having more than 14 leaflet pairs per leaf and by the fact that it does not produce buds during the winter. The plant typically flowers twice a year, with yellow flowers that rise 5-10 centimeters above the water surface. Plants automatically break into fragments post-flowering. New roots are produced at nodes along the stem and then the plant fragments at these nodes, allowing the plant to disperse. This species can produce seeds, but typically spreads via vegetative roots and fragments. Although the plant will die back before winter, the roots are capable of surviving until the following spring when it regrows when the water reaches approximately 60°F. Eurasian watermilfoil likely spread and became invasive due to the aquarium and aquatic nursery trade. However, this species is largely spread through transport on boating equipment. Ecologically, this species outcompetes native species and reduces the presence of other species. It often grows before other species can germinate and creates dense canopies that reduce light penetration and kill native species below. *Myriophyllum spicatum* requires stagnant to slowly moving water and can tolerate brackish conditions. It forms dense mats of leaves restricting light availability, leading to a decline in the diversity and abundance of native macrophytes. In addition, *Myriophyllum spicatum* displaces the native species of watermilfoil and reduces habitats for fish spawning and feeding. It is native to Europe, Asia, and northern Africa. (CISEH 2022ae).

Curlyleaf pondweed (Potamogeton crispus)

Potamogeton crispus is a perennial, submerged, aquatic herb that is native to Eurasia. Leaves are sessile, oblong, stiff, 1.6-3.9 inches (4-10 centimeters) long, 0.2-0.4 inches (5-10 millimeters) wide, translucent and have noticeably curly margins (resemble lasagna noodles). Flowering occurs in the summer to early fall when emergent flowers develop. Flowers are brown, inconspicuous and wind pollinated. Fruits are flat with a pointed beak and are 0.16-0.24 inches (4-6 millimeters) long. The seed do not seem to be viable. In the midsummer plants form turions (vegetative buds), from which new growth starts in fall or winter. *Potamogeton crispus* tolerates fresh or slightly brackish water and can grow in shallow, deep, still, or flowing water. Plants can grow in clear or turbid water but are mostly shade intolerant. The method of introduction is unclear, and it may have been introduced as a hitchhiker on boats, through the aquarium trade, or accidently when stock from a fish hatchery was released. It was first collected in 1860. (CISEH 2022af)

Narrowleaf cattails (Typha angustifolia, Typha x glauca)

Narrowleaf cattail is an aquatic perennial that grows in wetland areas, producing distinct brown spikes of flowers. While broadleaf cattail (*Typha latifolia*) is native to the United States, narrowleaf cattail (*Typha angustifolia*) was introduced from Europe, and where the two species occur together, they may hybridize. Cattails are found in wetland habitats, lakeshores, river backwaters, and roadside ditches. Seeds are dispersed by wind and may remain viable for up to 100 years. The species also spreads via underground roots. Stalks are light green, stiff, and round, and grow up to 3 meters tall. Leaves are long and narrow (5-15 millimeters) Invasive cattails may be distinguished from natives by clear separation of the lighter brown male flowers above the green female flowers. Invasive and hybrid cattails dominate shorelines, displacing native plants important for waterfowl and other wildlife. Ecologically, this species can be very invasive in disturbed wetlands, where it tends to invade native plant communities when hydrology, salinity, or fertility changes. In this case, they out-compete native species, often becoming monotypic stands of dense cattails. Maintaining water flows into the wetland, reducing nutrient input, and maintaining salinity in tidal marshes will help maintain desirable species composition. If cattails begin to invade, physical removal may be necessary. In recent decades it has expanded its range in many regions and become much more abundant, especially in roadside ditches and other highly disturbed habitats. As it often out-competes many native marsh species to produce very dense, pure stands, and hybridizes with *T. latifolia* to form the probably even more competitive *T. glauca*, *T. angustifolia* and *T. glauca* should perhaps be classified as noxious weeds in parts of North America. (USGS 2022b).

3.7.5.2 Invasive Aquatic Animals

Spiny water flea (Bythotrephes cederstroemi)

The spiny water flea is a tiny crustacean native to northern Europe and Asia. It is believed to have been introduced into the Great Lakes through ship ballast water and from sediment in ballast tanks. Spiny water fleas range in length from 0.25–0.6 inches long. They have a long tail that is twice as long as their bodies, with one to three pairs of barbs. The tail has a kink in the middle if the flea was produced asexually, while fleas without the kink are produced sexually. They also have a distinctive black eyespot. One of the characteristics that make spiny water fleas successful invaders is their ability to reproduce rapidly. The form of reproduction depends on the season and water temperature, as they can reproduce both sexually and asexually. Asexual reproduction takes place during the spring and summer. Sexual reproduction occurs in the fall when fertilized eggs that are resistant to drying and freezing are released, which then hatch during the spring. The spiny water flea is typically found in the upper water column of temperate lakes, where they are most abundant during the summer and fall. Their preferred conditions are water temperatures between 50-75°F with salinity levels between 0.04-0.4 parts per thousand. However, they can tolerate temperature ranges between 39-86°F and salinity levels between 0.04-8.0 parts per thousand (Liebig et al. 2022; MNDNR 2022a).

Spiny water fleas are voracious predators, eating up to 75 percent of their body weight each day by preying on zooplankton. The spiny water flea can disrupt the zooplankton community structure in lakes. They prey on native zooplankton and cause the decline or elimination of zooplankton species. They directly compete with larval fish who also rely on zooplankton. Spiny water fleas provide a food source for some fish, but native species are often unable to eat them because of their long tails and spines. Fishermen often encounter them because they foul fishing gear by getting hooked on fishing lines. They can be observed on fishing line in clumps that resemble a gelatinous blob (Liebig et al. 2022; MNDNR 2022a).

Zebra mussel (Dreissena polymorpha)

Zebra mussels were first introduced into the United States from the Black Sea to the Great Lakes. They are native to seas and rivers between eastern Europe and western Asia. Zebra mussels are small bivalves that are no larger than 50 millimeters long and named for the pattern on their shells: however, colors of the shell can vary, having only light or dark shells with no markings. Reproduction usually occurs during the spring or summer. Females produce approximately 40,000 eggs which are released into the water column and fertilized by males. Up to one million eggs can be produced per female during the spawning season. Larvae emerge after 3−5 days and remain free floating in the water currents until they develop enough to settle to the bottom and begin searching for a substrate to attach to. Adults are sexually mature when they reach 8-9 millimeters in length. Individuals typically live between 3 and 9 years. Zebra mussels prefer habitat conditions with optimal temperatures between 68-77°F, although they can tolerate a range of conditions and have shown growth in temperatures as low as 43°F. They feed on algae by efficiently filtering as much as 1 liter of water per day per individual (Benson et al. 2022).

Zebra mussels have spread to many waterways due to their free-floating larval form. Larval mussels then mature and attach to boats by threads and are easily transported to other waterways. They cause significant damage and problems because of their biofouling capabilities. They colonize rapidly and have been known to attach to surfaces in high densities, such as in pipes, reducing water flow and intake capabilities in many nuclear and hydroelectric plants. They also disrupt the natural ecosystems they invade. They reduce the amount of food available and therefore outcompete many native mussel species, which also reverberates up the food chain as it removes food sources from other species including fish. Zebra mussels also affect native mussels' species by directly attaching to them and restricting their ability to survive (Benson et al. 2022).

Asian carp (silver carp) (Hypophthalmichthys molitrix)

The silver carp is a deep-bodied fish that is compressed side-to-side. There is an abdominal keel from the throat to the vent. It is silver when young. Mature silver carp are green-brown on the back becoming lighter on the sides to silver on the belly. The fins are dark. There are no scales on the head and gill covers. The mouth is large and upturned. Teeth are present in the throat. The eyes are placed close to the mouth on the midline of the body and are slightly turned down. The gill rakers are branched. The maximum length of a silver carp is about 41.5 inches, and the maximum weight is about 110 pounds. (IDNR 2020a)

Silver carp mature at about 2 years of age and can live for about 20 years. They live in rivers and lakes, feeding on phytoplankton and zooplankton. Adults spawn when there is a high current, turbid water, temperatures above 59°F and plenty of oxygen in the water. The U.S. Fish and Wildlife Service lists all forms of live silver carp, their gametes, viable eggs, and hybrids as injurious fish. This species was originally imported to the United States in 1973 from eastern Asia, where it is native, and stocked for phytoplankton control and also as a food fish. By 1980 the species was discovered in natural waters, probably as a result of escapes from fish hatcheries and other types of aquaculture facilities. It has spread tremendously, in huge numbers, throughout rivers and streams. Commercial fisheries have been established along the Illinois and Mississippi Rivers to try and reduce the numbers of silver carp. This species is edible, and efforts are being made to increase its consumption by humans. Silver carp swim in schools and are known for jumping out of the water when disturbed, which can cause damage to people and boats. (IDNR 2020a)

Silver carp are known to occur below (downstream) of the dam.

Round goby (Neogobius melanostomus)

The round goby is native to the Black and Caspian seas and was first introduced into the Great Lakes via ballast water from transatlantic vessels. They are mottled with brown and black blotches, have a white to greenish dorsal fin and can grow up to 10 inches in length. One identifying characteristic is a black spot at the base of the dorsal fin. A second identifying characteristic that helps distinguish them from native sculpins are their fused pelvic fins. The fused pelvic fins form a suction disk that helps the fish anchor themselves to substrate when they are in fast moving waters. Round gobies prefer habitat with rocky substrate near the shore but can migrate and survive to deeper waters (50–60 meters) during the winter. However, they are capable of surviving in degraded water conditions. Females reach sexual maturity when they are 1–2 years old and males reach sexual maturity when they are 3–4 years old. The spawning season is long and lasts from April through September. Females are capable of producing between 300 to 5,000 eggs. The eggs are laid in nests that are guarded by the males. Round gobies are able to use a food resource that many other species cannot eat. They can feed on zebra mussels, with individuals capable of eating up to 78 mussels a day. They will also prey on small fish, eggs, and aquatic insects. This provides them an abundant food source. They also have a well-developed sensory system that allows them to feed in the dark by detecting water movement. This provides them with a significant advantage over native species (Freedman et al. 2022; Marsden and June 2003).

The round goby is known to outcompete native species, particularly the mottled sculpin, for spawning sites and food resources. They have also had a negative impact on lake trout populations as they prey on both eggs and young trout. There is also a concern that because round gobies consume zebra mussels, they will transfer contaminants to sport fish that prey on them. Also, birds preying on round gobies are more likely to be infected with avian botulism (Freedman et al. 2022; Marsden and June 2003).

3.7.5.3 Invasive Terrestrial Plants

Poison hemlock (Conium maculatum)

This herbaceous member of the carrot family has the distinction of being one of the most poisonous plants in the United States. Ingesting even a small amount of this plant can lead to death. Poison hemlock can form very dense patches, particularly in areas with disturbed soil. It prefers sites with full sun. It often is found along roadsides and railroad ROWs and in ditches and old fields. While poison hemlock is a threat to natural communities, it is also a concern to livestock producers as a contaminate in hay. (Evans 2016)

Tree-of-heaven (Ailanthus altissima)

Ailanthus altissima is a rapidly growing, typically small tree up to 80 feet (24.4 meters) in height and 6 feet (1.8 meters) in diameter. It has large leaf scars on the twigs. Foliage is one of the best identifying characteristics for this species. The leaves are pinnately compound and 1-4 feet (0.3-1.2 meters) in length with 10-41 leaflets. Tree-of-heaven resembles native sumac and hickory species, but it is easily distinguished by the glandular, notched base on each leaflet. This species is dioecious, and flowering occurs in early summer when large clusters of yellow flowers develop above the foliage. Fruit produced on female plants are tan to reddish, single winged and can be wind or water dispersed. Tree-of-heaven forms dense, clonal thickets which displace native species and can rapidly invade fields, meadows, and harvested forests. This invasive tree species is extremely tolerant of poor soil conditions and can even grow in cement cracks. This species is not shade tolerant, but easily invades disturbed forests or forest edges causing habitat damage. Introduced as an ornamental, it was widely planted in cities because of its ability to grow in poor conditions. Management and control efforts for this species continue across the United States at great economic cost. (CISEH 2022ag)

Mimosa (Albizia julibrissin)

Albizia julibrissin is a small tree that is 10-50 feet (3-15.2 meters) in height, often having multiple trunks. It has delicate-looking, bi-pinnately compound leaves that resemble ferns. Flowering occurs in early summer, when very showy, fragrant, pink flowers develop in groups at the ends of the branches. Fruit is flat, 6 inches (15.2 centimeters) long seed pods that develop in the late summer. Mimosa invades any type of disturbed habitat. It is commonly found in old fields, stream banks, and roadsides. Once established, mimosa is difficult to remove due to the long-lived seeds and its ability to re-sprout vigorously. This tree is native to Asia and was first introduced into the United States in 1745. It has been widely used as an ornamental. (CISEH 2022ah)

Autumn olive (Elaeagnus umbellate)

Elaeagnus umbellate is a deciduous shrub from 3-20 feet (0.9-6.1 meters) in height with thorny branches. It is easily recognized by the silvery, dotted underside of the leaves. Leaves are alternate, 2-3 inches (5-8 centimeters) long and 1 inch (2.5 centimeters) wide. The margins are entire and undulate. Leaves are bright green to gray green above and silver scaly beneath with short petioles. Small, yellowish tubular flowers are abundant and occur in clusters of five to 10 near the stems from February to June. Fruits are round, red, juicy drupes which are finely dotted with silvery to silvery-brown scales. Each drupe contains one seed. Fruits ripen from August to November. Autumn olive invades old fields, woodland edges, and other disturbed areas. It can form a dense shrub layer which displaces native species and closes open areas. Autumn olive is native to China and Japan and was introduced into North America in 1830. Since then, it has been widely planted for wildlife habitat, mine reclamation, and shelterbelts. It is a non-leguminous nitrogen fixer. (CISEH 2022ai)

Glossy buckthorn (Frangula alnus)

Frangula alnus is a large shrub or small tree that can grow to heights of 30 feet (9.1 meters). Its bark is gray to brown with white lenticels. The dark green leaves are shiny, alternate (sometime opposite) and simple with prominent venation. The flowers are inconspicuous, pale greenish yellow to yellow in color and occur in clusters in the leaf axis. Flowering occurs from May through September. The fleshy fruit ripens from red to a dark purple or black color. You can see ripe fruit beginning about July through September. *Frangula alnus* invades moist woodlands and disturbed areas throughout the Northeast and Midwest. Its rapid growth and prolific seed production make this plant an aggressive invader that can form dense thickets which shade and displace native understory plants, shrubs, and tree seedlings. This plant is native to Europe and was first introduced into the United States in the mid-1800s as an ornamental. (CISEH 2022aj)

Japanese barberry (Berberis thunbergia)

Berberis thunbergia is a small deciduous shrub from 2-8 feet (0.6-2.4 meters) tall. The thin, grooved branches have thin, straight spines. This shrub is very shade-tolerant and can form dense stands which shade out and displace native species. The leaves are up to 1 inch (24 millimeters) long and paddle shaped. The pale-yellow flowers occur in drooping clusters of 2-5 and develop in mid-spring to early summer. The berries ripen to a bright red color and are 0.25-0.3 inches (7-10 millimeters) long. Japanese barberry invades a variety of habitats from shaded woodlands to open fields and wetlands and is rapidly spread by birds that eat the berries thus dispersing the seeds. It is native to Asia and was first introduced into the United States in 1864 as an ornamental. It is still widely planted for landscaping and hedges. (CISEH 2022ak)

Amur honeysuckle (Lonicera maackii)

Lonicera maackii is a woody perennial shrub that can grow up to 16.5 feet (5 meters) in height. The oppositely arranged leaves are ovate to lance-ovate in shape and measure 1.3-3.3 inches (3.5-8.5 centimeters) long. The tips of the leaves are acuminate. The leaves are dark green above and lighter on the lower surface. The veins of the leaves are pubescent. The white flowers are found in erect pairs that are on peduncles shorter than the petioles. The flowers measure 0.6-0.75 inches (1.5-2 centimeters) long and are bilabiate. The flowers appear on the plant from late May to early June, which is later than the other honeysuckles. The fruit are dark red in color, spherical in shape and measure 0.25 inches (6 millimeters) in diameter. The fruit become ripe on the plant in the late fall. Amur honeysuckle can form large stands that prevent native shrubs and herbaceous understory plants from growing. The fruits persist on the branches into the winter when birds feed on them. In the spring, Amur honeysuckle is one of the first plants to leaf out, giving it a competitive advantage. This shrub can bear fruit when it is as young as 3−5 years old. The Amur honeysuckle is very troublesome in the southern and midwestern parts of the country. (CISEH 2022al)

Morrow's honeysuckle (Lonicera morrowii)

Lonicera morrowii is a multi-stemmed, upright, deciduous shrub that grows up to 8 feet (2.5 meters) tall. The bark is light brown and often pubescent on young stems. Stems are hollow. The grayish-green leaves are opposite, elliptic to oblong, 2-3 inches (5.1-7.6 centimeters) long and hairy underneath. Often it is one of the first shrubs to leaf out in the spring. The fragrant paired flowers are tubular, white to cream-colored, 0.75 inches (1.9 centimeters) in diameter and develop from May to June. The abundant berries are 0.25 inches (0.6 centimeters) in diameter, ripen to orange or red in color, often persist throughout winter and occur on 0.5-inch (1.3 centimeter) pedicels. Morrow's honeysuckle readily invades open woodlands, old fields, and other disturbed sites. It can spread rapidly due to birds and mammals dispersing the seeds and can form a dense understory thicket which can restrict native plant growth and tree seedling establishment. This plant is a native of eastern Asia and was first introduced into North America in the late 1800s. It has been planted widely as an ornamental and for wildlife food and cover. (CISEH 2022am)

Tartarian honeysuckle (Lonicera tatarica)

Lonicera tatarica is a multistemmed, upright, woody, deciduous shrub that grows up to 10 feet (3 meters) tall. The bark is light gray and can often peel in vertical strips. The leaves are opposite, ovate, 1.5-2.5 inches (3.8-6.4 centimeters) long and blue green. Often, it is one of the first shrubs to leaf out in the spring. Flowers develop in pairs in the axils of the leaves in May to June. Flowers are deeply five lobed, tubular, usually pink to red and rarely white. The abundant paired berries are 0.25 inches (0.6 centimeters) in diameter, ripen to an orange to red color and often persist throughout winter. *Lonicera tatarica* readily invades open woodlands, old fields, and other disturbed sites. It can spread rapidly due to birds and mammals dispersing the seeds and can form an extremely dense understory thicket which can restrict native plant growth and tree seedling establishment. This plant is a native of eastern Asia and was first introduced into North America as an ornamental in 1752. (CISEH 2022an)

Callery pear (Bradford pear) (Pyrus calleryana)

The Bradford pear is one of several cultivars of *Pyrus calleryana*. It is a deciduous tree that can grow up to 60 feet (18 meters) in height and 2 feet (0.6 meters) in diameter. The leaves are alternate, simple, 2-3 inch (5.1-7.6 centimeter) long, petiolate, and shiny with wavy, slightly toothed margins. Flowering occurs early in the spring (April to May) before the leaves emerge. The flowers are 1 inch (2.5 centimeter) wide, showy, malodorous, and white. It is insect pollinated. Fruits are round, 0.5 inch (1.3 centimeter) in diameter and green to brown in color.

Pyrus calleryana produce sterile fruits because they do not self-pollinate. They have been widely planted throughout the United States since the early 1900s as an ornamental. New cultivars of *Pyrus calleryana* were bred to reduce the tree's tendency to split in snow or high winds. The Bradford pear cultivar, other *P. calleryana* cultivars and *P. betulifolia* or Asian pear, can hybridize and produce fertile fruit. In addition to this, fertile pear varieties are commonly used as the rootstock when grafting. If the grafted crown is damaged the fertile rootstock can them dominate, producing fertile fruit. These factors and others may have contributed to the trees seeding out into natural areas and becoming an invasive problem. (CISEH 2022ao)

Princesstree (Paulownia tomentosa)

Paulownia tomentosa is a medium sized tree 50-60 feet (15.2-18.3 meters) in height and 2 feet (0.6 meters) in diameter that can commonly be mistaken for the native tree northern catalpa (*Catalpa speciosa*). Bark is gray-brown and rough, often developing lighter-colored shallow vertical fissures. Leaves are large, broadly oval to heart-shaped 6-12 inches (15.2-30.5 centimeters) long, 5-9 inches (12.7-22.8 centimeters) wide and arranged opposite along the stem, hairy on both surfaces. Petioles are also hairy and can be sticky when young. Leaves growing off root sprouts have been measured up to 2 feet (0.6 meters) in length. Twigs are stout, brown, and speckled with white dots (lenticels). They can be slightly hairy when young. Lateral leaf scars are somewhat round, becoming darker and sunken. The pith is chambered or sometimes hollow. Large flowers 2 inch (5.1 centimeters) long are fragrant and light violet-pink, appearing in showy upright clusters 8-12 inches (20.3-30.5 centimeters) in length in early spring (April-May) before leaves emerge. They have tubular corollas, ending in five unequal lobes. Flower buds are hairy and linear, becoming round. Fruits 1-2 inches (2.5-5.1 centimeters) long, 1-1.5 inches (2.5-3.8 centimeters) wide are egg-shaped capsules, divided into four inner compartments that contain the seeds. Fruits are light green in the summer, becoming dark brown in the winter, and persist in clusters on the tree until the following spring. The capsules split in half during late winter to release up to 2,000 tiny, winged, wind-borne seeds 0.08-0.12 inches (2-3 millimeters). *Paulownia tomentosa* is an aggressive tree that invades disturbed natural areas including forests, roadsides, and stream banks. It is native to China and was first introduced into the United States as an ornamental in 1840. (CISEH 2022ap)

European buckthorn (common buckthorn) (Rhamnus cathartica)

Rhamnus cathartica is a deciduous shrub or small tree that can grow to 25 feet (7.6 meters) in height. The bark is dark gray, and the inner bark is orange (easily seen when the tree is cut). Twigs are usually tipped with a sharp spine. The leaf arrangement is usually sub-opposite, but examples of opposite and/or alternate arrangements are commonly found. Leaves are dark green, oval, 1.5-3 inches (3.8–7.6 centimeters) long, slightly serrate with three to four pairs of curving veins and a somewhat folded tip. Flowering occurs in the spring, with fragrant, yellow-green, 4-petaled flowers developing in clusters of two to six near the base of the petioles. Plants are dioecious (male and female flowers occur on separate plants). Appearing in the fall, the small, purple to black fruit are 0.25 inches (0.6 centimeters) in diameter. The fruit contains 3−4 seeds. Birds and other wildlife eat the fruit and disperse the seeds. *Rhamnus cathartica* invades forests, prairies, and savannas in the Midwestern United States and can form dense thickets crowding out native shrubs and understory plants. It is difficult to remove and can regenerate after cutting or burning. It is a native of Europe and was introduced into the United States as an ornamental shrub. (CISEH 2022aq)

Black locust (Robinia pseudoacacia)

Robinia pseudoacacia is a deciduous tree that, while native to parts of the United States, has spread to and become invasive in other parts of the country. Trees grow from 40-100 feet (12-30 meters) in height. Trees grow upright in forests but develop an open growth form in more open areas. The bark of black locust is light brown, rough, and becomes very furrowed with age. Leaves are pinnately compound with 7–21 small, round leaflets per leaf. Leaflets are 1.5 inches (4 centimeters) long. A pair of long, stipular spines is found at the base of most leaves. Flowering occurs in the spring, when showy, fragrant, white to yellow flowers develop in 8 inch (20.3 centimeter) long clusters. The flowers give way to a smooth, thin seed pod that is 2–4 inches (5.1–10.2 centimeters) in length. *Robinia pseudoacacia* is native to the Southern Appalachians, the Ozarks, and other portions of the Midsouth, but is considered an invasive species in the prairie and savanna regions of the Midwest where it can dominate and shade those open habitats. (CISEH 2022ar)

Multiflora rose (Rosa multiflora)

Rosa multiflora is a multistemmed, thorny, perennial shrub that grows up to 15 feet (4.6 meters) tall. The stems are green to red arching canes which are round in cross section and have stiff, curved thorns. Leaves are pinnately compound with seven to nine leaflets. Leaflets are oblong, 1–1.5 inches (2.5-3.8 centimeters) long and have serrated edges. The fringed petioles of *Rosa multiflora* usually distinguish it from most other rose species. Small, white to pinkish, five petaled flowers occur abundantly in clusters on the plant in the spring. Fruit are small, red rose hips that remain on the plant throughout the winter. Birds and other wildlife eat the fruit and disperse the seeds. *Rosa multiflora* forms impenetrable thickets in pastures, fields, and forest edges. It restricts human, livestock, and wildlife movement and displaces native vegetation. It tolerates a wide range of conditions allowing it to invade habitats across the United States. *Rosa multiflora* is native to Asia and was first introduced to North America in 1866 as rootstock for ornamental roses. During the mid-1900s it was widely planted as a "living fence" for livestock control. (CISEH 2022as)

Winged burning bush (Euonymus alatus)

Euonymus alatus is a deciduous shrub, up to 20 feet (6.1 meters) in height, which invades forests throughout the eastern United States. Two to four corky ridges often form along the length of young stems, though they may not appear in shaded areas or closed canopies. The opposite, dark green leaves are less than 2 inches (5 centimeters) long, smooth, rounded and taper at the tips. The leaves turn a bright crimson to purplish color in the fall. The flowers are inconspicuous, are greenish yellow and have four petals. Flowers develop from late April to June and lay flat against the leaves. The fruit which appears from September to October are reddish capsules that split to reveal orange fleshy seeds. *Euonymus alatus* can invade not only a variety of disturbed habitats including forest edges, old fields, and roadsides but also in undisturbed forests. Birds and other wildlife eat and disperse the fruit. Once established, it can form dense thickets, displacing native vegetation. It is native to northeastern Asia and was first introduced into North America in the 1860s for ornamental purposes. This plant is still sold and planted as an ornamental. (CISEH 2022at)

Chinese privet (Ligustrum sinense)

Ligustrum sinense is a semi-evergreen shrub or small tree that grows to 20 feet (6.1 meters) in height. Trunks usually occur as multiple stems with many long, leafy branches. Leaves are opposite, oblong, 1-2.4 inches (2.5-6 centimeters) long, and 0.2-0.6 inches (0.5-1.5 centimeters) wide. Foliage can be pubescent along the underside of the midvein. Flowering occurs from April to June, when panicles of white to cream flowers develop in terminal and upper axillary clusters. Pollen can cause an allergic reaction in some people. The abundant fruits are spherical and 0.3-0.5 inches (1-1.3 centimeters) long. Fruit begins green, ripens to dark purple to black, and persists into winter. Birds and other wildlife eat the fruit and disperse the seeds. Seed soil viability is about one year. The plant also colonizes by root sprouts. Several privet species occur and distinguishing among them can be difficult. *Ligustrum sinense* can tolerate a wide range of conditions. Plants form dense thickets, invading fields, fencerows, roadsides, forest understories, and riparian sites. They can shade out and exclude native understory species, perhaps even reducing tree recruitment. Native to Europe and Asia, *Ligustrum sinense* was introduced in the United States in 1852 as an ornamental plant. It is commonly used as an ornamental shrub and for hedgerows. (CISEH 2022au)

Japanese chaff flower (Achyranthes japonica)

Achyranthes japonica is a perennial herb that can grow up to about 6.5 feet (2 meters) tall. Stems are glabrous or slightly pubescent. Ovate-elliptic leaves are opposite and simple. Margins are entire and repand (slightly wavy). The base of the leaf is tapering, and the apex is acute to acuminate. The small flowers have no petals and are clustered tightly on the inflorescence which occur at the ends of the stems and upper branches. They flower in summer. The fruits are elliptic utricles that are held tightly along the stem. Fruits contain a single seed, and each plant produces many seeds. Each fruit has a pair of stiff bracts that can attach to fur or clothing, allowing the seed to be easily spread. Although *Achyranthes japonica* prefers partial sun and moist soils it can survive in shade and dry conditions. It readily invades bottomland forests, wooded riverbanks, roadsides, ditches, and field edges. *Achyranthes japonica* can form dense monocultures shading and outcompeting native plant species. (CISEH 2022av)

Garlic mustard (Alliaria petiolate)

Alliaria petiolate is an herbaceous, biennial forb. First-year plants are basal rosettes which bolt and flower in the second year. Plants can be easily recognized by a garlic odor that is present when any part of the plant is crushed. Foliage on first year rosettes is green, heart shaped, 1−6 inch (2.5−15.2 centimeter) long leaves. Foliage becomes more triangular and strongly toothed as the plant matures. Second year plants produce a 1−4 foot (0.3−1.2 meter) tall flowering stalk. Each flower has four small, white petals in the early spring. Mature seeds are shiny black and produced in erect, slender green pods which turn pale brown when mature. *Alliaria petiolate* is an aggressive invader of wooded areas throughout the eastern and middle United States. A high shade tolerance allows this plant to invade high quality, mature woodlands, where it can form dense stands. These stands not only shade out native understory flora but also produce allelopathic compounds that inhibit seed germination of other species. *Alliaria petiolate* is native to Europe and was first introduced during the 1800s for medicinal and culinary purposes. (CISEH 2022aw)

Musk thistle (Carduus nutans)

Carduus nutans is an herbaceous, biennial plant that grows to 6 feet (1.8 meters) tall. The stem has very spiny wings. Carduus species may hybridize with each other. Leaves are green and lanceolate to oblong lanceolate. They are often pinnatifid and are very prickly. Leaves are usually sessile to slightly clasping. Basal leaves are 4−16 inches (10−40 centimeters) long. Leaf characteristics are variable across different varieties and subspecies. Showy, solitary, hemispherical, red to purple, disk flowers bloom from June to September. Phyllaries are spine tipped and overlap with several rows. Fruits are small achenes, 1.52 inches (45 millimeters) long, about 0.04 inches (1 millimeter) in diameter, including a white to light brown pappus. The seeds have longitudinal dotted stripes. *Carduus nutans* invades a variety of disturbed areas. Pastures are particularly at risk because it is unpalatable to livestock. Once established it can spread rapidly due to high seed production (as much as 120,000 seed per plant). *Carduus nutans* is native to Western Europe and was accidentally introduced into the United States in the early 1900s. (CISEH 2022ax)

Spotted knapweed (Centaurea stoebe ssp. Micranthos)

Centaurea stoebe ssp. Micranthos is an herbaceous biennial or perennial plant that readily invades open areas. Its name is derived from the black margins of the flower bract tips which give the flower heads a spotted look. A basal rosette of deeply lobed leaves is produced the first year. Rosette leaves are deeply lobed, petiolate, and approximately 8 inches (20 centimeters) long. Flowering stems are 1-4 feet (0.3-1.2 meters) tall and branched. Stem leaves are alternate and may be slightly lobed or linear. Leaves become smaller and less lobed toward the apex. The small purple to pink flowers bloom in the early summer. Reproduction of spotted knapweed occurs solely by seed. Hundreds and/or thousands of seeds are produced. Seeds are easily distributed by wind, animals, and contaminated hay. Seeds can remain viable in the soil for up to 8 years. *Centaurea stoebe ssp. Micranthos* invades a wide variety of habitats including pastures, open forests, prairies, meadows, old fields, and disturbed areas. It displaces native vegetation and reduces the forage potential for wildlife and livestock. It is native to Europe and western Asia. It was accidentally introduced into North America in contaminated alfalfa and clover seed in the late 1800s. (CISEH 2022ay).

Canada thistle (Cirsium arvense)

Cirsium arvense, a rhizomatous perennial grows from 1-5 feet (0.3-1.5 meters) tall. Roots can grow deep into the ground. Stems do not have conspicuous spines. Leaves are dark green and lanceolate to oblong lanceolate. They are glabrous above, but their undersides have short, white hairs. They may be pinnatifid and very prickly. Basal leaves are 5-8 inches (12-20 centimeters) long. Leaves are usually sessile to slightly clasping. Leaf characteristics are variable across different varieties and subspecies. It has male and female plants. Female flowers are flask-shaped, 0.4-0.6 inches (1-1.5 centimeters) in diameter, and 0.4-0.75 inches (1-2 centimeters) tall. Female flowers are fragrant, the male flowers are not. Male flowers are smaller and more globose than the female flowers. Flowers range from purple to pink or white. It blooms from June to August. Fruits are tiny, 0.1 inches (2-3 millimeters) long, about 0.04 inches (1 millimeter) in diameter, with a white to light brown pappus. *Cirsium arvense* is most commonly found in agricultural and disturbed sites, or sites that are undergoing restoration. It is shade intolerant and therefore is rarely found within wooded sites, except in clearings. It is found in some dry, sandy sites, but more commonly on the edges of wet habitats such as stream banks and lake shores. In the western and northern United States, it presents a significant problem in prairie and riparian habitats. (CISEH 2022az)

Bull thistle (Cirsium vulgare)

Cirsium vulgare is an annual or biennial, herbaceous plant that invades disturbed areas throughout the United States. The spiny, spreading, winged stems are up to 7 feet (2.1 meters) tall. Leaves are 3-12 inches (7.6-30.5 centimeters) long, lance-shaped, and very hairy. Flowers develop, at the apex of the plant, from June to September. The purple flower heads are 1.5-2 inches (3.8-5.1 centimeters) in diameter and 1-2 inches (2.5-5.1 centimeters) long with narrow, spine-tipped bracts. Fruits have several bristles on the tip and are up to 0.2 inches (5 millimeters) long. *Cirsium vulgare* can invade almost any type of disturbed area, such as forest clearcuts, riparian areas and pastures. Plants can form dense thickets, displacing other vegetation. The spiny nature of the plant renders it unpalatable to wildlife and livestock and reduces the forage potential of pastures. *Cirsium vulgare* is native to Europe, western Asia, and northern Africa. It is thought to have been introduced to the eastern United States during colonial times and the western United States in the late 1800s. It is currently found in all 50 states. (CISEH 2022ba)

Black dog-strangling vine (Vincetoxicum nigrum)

Vincetoxicum nigrum is an herbaceous, twining, unbranched, perennial vine which can grow up to 6.5 feet (2 meters) in length. Leaves are opposite, dark green, oval, and shiny with entire margins. Leaves are from 3-4 inches (7.6-10.2 centimeters) long and 2-3 inches (5.1-7.6 centimeters) wide. A short petiole attaches the leaf to the vine. Clusters of 6-10 flowers bloom from June to September. Five lobed dark purple corollas are approximately 0.25 inches (0.6 centimeters) across and covered with short white hairs on the upper surface. Fruit are pods, similar to milkweed pods, which are slender, 2-3 inches (5.1-7.6 centimeters) long and split to reveal small seeds with tufts of white hairs. The hairs allow the seeds to be readily dispersed by wind. Plants have rhizomes that sprout new plants. *Vincetoxicum nigrum* readily invades upland areas. It tolerates a wide range of light and moisture conditions and can be found invading a wide variety of upland habitat types. It is native to Europe. The history of its introduction is uncertain, but it may have escaped from a botanical garden. (CISEH 2022bb)

Common teasel (Dipsacus fullonum)

Dipsacus fullonum a biennial plant that exists as a basal rosette until flower stems develop. Rosette leaves are lanceolate to oblanceolate and stem leaves are opposite, lanceolate, and fused at the base. All leaves have short prickles on the midvein. The erect flower stems reach 6 feet (1.8 meters) in height and support spiny flower heads that are covered with small, lavender to white flowers in April to September. Fruit is angled and approximately 0.08-0.12 inches (2-3 millimeters) long. Seeds are small and are dispersed by the wind after the seed-head has dried. *Dipsacus fullonum* favors disturbed sites such as roadsides, ditches, waste places, riparian sites, fields, and pastures in most of the continental United States. Only recently was *Dipsacus fullonum* distinguished from Fullers' teasel which was once cultivated for the dried flower heads used in wool processing. It is native to Europe. (CISEH 2022bc)

Cut-leaved teasel (Dipsacus laciniatus)

Dipsacus laciniatus is a monocarpic perennial plant that grows as a basal rosette for at least a year until sending up a flowering stalk that can reach 6-7 feet (1.8-2.1 meters) in height. The plant dies after flowering. Opposite leaves are joined at the base and form cups that surround the prickly stem. The small, white flowers densely cover oval flower heads and are present from July to September. Spiny bracts are located on the ends of flower stems. A single plant can produce up to 2,000 seeds and can remain viable in the soil for at least 2 years. *Dipsacus laciniatus* grows in open, sunny habitats preferring roadsides and other disturbed areas, although it can sometimes be found in high quality areas such as prairies, savannas, seeps, and sedge meadows. It was introduced from Europe in the 1700s and spreads by producing abundant seeds. It can be found in the northern states from Massachusetts to Colorado. This is an early detection/rapid response plant for the Southeastern United States. It has been reported in Virginia, West Virginia, and Kentucky. (CISEH 2022bd)

Leafy spurge (Euphorbia esula)

Euphorbia esula is an erect, perennial, herbaceous plant that grows from 2-3.5 feet (0.6-1.1 meters) tall. The stem is smooth and bluish green. The plant produces a milky sap if stem is broken, or a leaf is removed. Leaves are lance shaped, smooth and 1-4 inches (2.5-10.2 centimeters) long. They are arranged alternately along the stem, becoming shorter and more ovate towards the top of the stem. Flowering occurs in June, when yellow flowers develop in clusters at the apex of the plant. Fruits are three lobed capsules that explode when mature, propelling brown mottled ovoid seeds up to 15 feet (4.6 meters) away. Large infestations of *Euphorbia esula* give the landscape a yellowish tinge due to the yellow bracts.

Leafy spurge invades prairies, pastures, and other open areas. It is a major pest of national parks and nature preserves in the western United States. It can completely overtake large areas of land and displace native vegetation. This plant is native to Europe and was introduced accidentally into North America in the early 1800s as a seed contaminate. (CISEH 2022be)

Giant Hogweed (Heracleum mantegazzianum)

Heracleum mantegazzianum is an herbaceous biennial or monocarpic perennial that can grow up to 15-20 feet (4.3-5.8 meters) in height. The stem is hollow and usually blotched with purple. Both the leaf stalks and stem produce pustulate bristles. The stem can be 2-4 inches (4.8-9.6 centimeters) in diameter. The leaves are ternate or ternate-pinnate with pinnately lobed lateral segments. They can be up to 9.8 feet (3 meters) in breadth. *Heracleum mantegazzianum* flowers from June-July. The inflorescence has many white florets with petals about 0.4 inches (1 centimeter) that form a flat-topped umbel. Each inflorescence can have a diameter of up to 2.5 feet (0.72 meters). The fruits are dry and elliptic, measuring 0.3-0.4 inches (8-11 millimeters) long and 0.25-0.3 inches (6-8 millimeters) wide. The fruits have brown resin canals that can be up to 0.04 inches (1 millimeter) in diameter. *Heracleum mantegazzianum* can outcompete species for habitat, especially in riparian zones, and it may cause increased soil erosion. This plant is on the federal noxious weed list because of its poisonous sap. This sap makes skin very sensitive to UV radiation, causing blistering and severe burns. Caution should be taken when handling this weed. Removing it manually becomes very difficult because of the danger caused by its sap. (CISEH 2022bf)

Bicolor lespedeza (Lespedeza bicolor)

Lespedeza bicolor is an upright semi-woody forb, 3-10 feet (0.9-3 meters) in height with many slender stems and arching branches. Leaves are elliptical, alternate, abundant, and three-parted. Leaflets are oval with the lower surface lighter than the upper surface. Flowering occurs in the summer, when purple, pea-like flowers develop in clusters. Flowers are less than 0.5 inches (1.3 centimeters) long. The fruit are flat, indehiscent pods and contain one seed that measure up to 0.31 inches (8 millimeters) long. *Lespedeza bicolor* is an extremely aggressive invader of open areas, forming dense thickets, which displace native vegetation. Native to Asia and introduced into the United States in the late 1800s, it has been widely planted for wildlife habitat, especially for northern bobwhite quail. (CISEH 2022bg)

Sericea lespedeza (Lespedeza cuneata)

Lespedeza cuneata is an upright semi-woody forb reaching 3-6 feet (0.9-1.8 meters) in height with one or many slender stems. Stems are often gray green with lines of hairs along the stem. Leaves are thin, alternate, abundant, and three-parted. Leaflets have wedge-shaped bases and are 0.5-1 inches (1.3-2.5 centimeters) long and hairy. Flowering occurs from July to September, when small, creamy-white flowers with purple throats develop in clusters of two to four. Fruit is a flat ovate to round single-seeded pod 0.12-0.15 inches (3-4 millimeters) wide. Pods are clustered in terminal axils, scattered along the stem, and clasped by persistent sepals.

Lespedeza cuneata is an extremely aggressive invader of open areas and out competes native vegetation. Once established, *Lespedeza cuneata* is very difficult to remove due to the seed bank which may remain viable for decades. Native to Asia and introduced into the United States in the late 1800s, it has been widely planted for erosion control, mine reclamation and wildlife habitat. (CISEH 2022bh)

Crownvetch (Securigera varia)

Securigera varia is a low-growing, herbaceous vine that usually forms thickets up to 3 feet (0.9 meters) in height. The leaves are dark green pinnately compound with 9−25 pairs of leaflets and a terminal leaflet. Leaflets are 0.75 inches (1.9 centimeters) long. Flowering occurs in the summer. The pea-like, fragrant flowers are white to pink to purple and resemble a large clover flower because they are found in long-stalked clusters. Seed pods are segmented, pointed, borne in crown-like clusters. The straw-colored seeds are less than 0.3 inches (0.9 centimeters) long, round, flat, and winged. *Securigera varia* reproduces and spreads rapidly by rhizomes as well as seeds. It forms dense thickets in open, disturbed areas such as fields and roadsides. Once established it is difficult to remove. *Securigera varia* is native to Europe, Asia, and Africa. It was first introduced into North America around the 1950s and has been widely planted for erosion control. (CISEH 2022bi)

Japanese stiltgrass (Microstegium vimineum)

Microstegium vimineum is a delicate, sprawling, annual grass that is 0.5–3.5 feet (0.2–1.1 meters) in height. The stems can root at the nodes. The leaves are pale-green, alternate, lance-shaped, 1–3 inches (2.5–7.6 centimeters) long, asymmetrical with a shiny, off-center midrib. Upper and lower leaf surface is slightly pubescent. A silvery line runs down the center of the blade. Stems usually droop. Flowering begins in September, when delicate flower stalks develop in the axils of the leaves or at the top of the stems. Fruit is produced from late September through early October. Most commonly an invader of forested floodplains, *Microstegium vimineum* is also found in ditches, forest edges, fields, and trails. It is very shade tolerant and can completely displace native vegetation. It is native to Asia and was accidentally introduced into North America sometime around 1920. It has previously been used as packing material for porcelain, possibly explaining its accidental introduction. (CISEH 2022bj)

Chocolate Vine (Akebia) (Akebia quinata)

Akebia quinata is an invasive deciduous to evergreen climbing or trailing vine that invades forested areas throughout the eastern half of the United States, including Illinois. The twining vines are green when young, turning brown as they age. The leaves are palmately compound with up to five, 1.5–3 inches (2.5–7.6 centimeters) long, oval leaflets. Flowering occurs in the mid-spring, when small, purple to red, fragrant flowers develop. Fruit, which are rarely produced, are purple seed pods that contain white pulp and small black seeds. *Akebia quinate* is able to invade forested habitats because it is shade tolerant. The dense mat of vines formed can displace native understory species. It can also climb into, smother, and kill small trees and shrubs. *Akebia quinate* is native to eastern Asia and was first introduced into the United States in 1845 as an ornamental. (CISEH 2022bk)

Oriental bittersweet (Celastrus orbiculatus)

Celastrus orbiculatus is a perennial deciduous, climbing, woody vine that can grow to lengths of 60 feet (18.3 meters) and up to 4 inches (10 centimeters) in diameter. The striated bark is brown to dark brown. The smooth glabrous twigs can range from light gray to dark brown in color. The alternate, elliptical to circular leaves are light green in color and 2–5 inches (5–13 centimeters) long. Small, inconspicuous, axillary, greenish-white flowers bloom from May to early June. Oriental bittersweet closely resembles American bittersweet (*Celastrus scandens*). The main difference: *Celastrus scandens* has flowers and fruits at the ends of branches; *Celastrus orbiculatus* has flowers in the axils of the leaves. The small globose fruits are green when young; ripen to yellow; then split to reveal showy, scarlet berries that persist into winter. *Celastrus orbiculatus* is commonly found in old home sites, fields, and road edges. The fast-growing vines can cover, shade, and outcompete other vegetation. It can even girdle and kill large trees. Birds and other wildlife eat the fruit, thus distributing the seeds. It hybridizes with *Celastrus scandens*, potentially leading to loss of genetic identity for the native species. It was introduced from China around 1860 as an ornamental. (CISEH 2022bl)

Chinese yam (Dioscorea polystachya)

Dioscorea polystachya is an invasive herbaceous, twining vine that grows to about 16.4 feet (5 meters). It invades open to shady areas in the eastern half of the United States, including Illinois. The leaves are alternate proximally but can become opposite as they advance up the vine. They are about 3−6 inches long, 3−4 inches wide and heart to fiddle shaped (margins three-lobed), with prominent, parallel veins. The petiole base is not clasping. Leaves are usually more rounded when young or on young plants and fiddle shaped farther along the stem and on older plants. The rounded stems are thin and wiry. The staminate plants may produce small, white flowers annually. The seeds are winged all around, but the chief means of reproduction are aerial, potato-like tubers (bulbils) located at the leaf axils and underground tubers. *Dioscorea polystachya* can form dense masses of vines that cover and kill native vegetation, including trees, within a variety of moist, disturbed habitats. It was introduced from Asia for ornamental, food, and medicinal purposes and escaped cultivation in the mid-1990s. (CISEH 2022bm)

Japanese hop (Humulus japonicus)

Humulus japonicus is an annual, climbing, or trailing vine that is native to eastern Asia. This vine has five-lobed leaves (generally), downward pointing prickles on the stem and bracts at the base of the petioles. Leaves are opposite, rough, 2–5 inches (5–13 centimeters) long, 5–9 lobed with toothed margins. Most leaves will have five lobes, but the upper leaves may only have three. Flowers originate in the leaf axils and are green with five petals. Male and female flowers occur on separate plants (dioecious). Female flowers occur in cone-shaped clusters that hang down and the male flowers occur in upright flower stems. Fruit is a yellow-brown ovoid achene. The small seeds are distributed by wind and water. These vines can grow to 35 feet (10.7 meters) in one growing season, allowing them to infest large areas crowding and out competing native vegetation. *Humulus japonicus* was introduced into North America in the mid-to-late 1800s as an ornamental. (CISEH 2022bn)

Japanese honeysuckle (Lonicera japonica)

Lonicera japonica is a woody perennial, evergreen to semi-evergreen vine that can be found either trailing or climbing to over 80 feet (24 meters) in length. Young stems may be pubescent while older stems are glabrous. Leaves are opposite, pubescent, oval and 1–2.5 inches (2.5–6.4 centimeters) long. Margins are usually entire but young leaves may be lobed or toothed. Flowering occurs from April to July, when showy, fragrant, tubular, whitish-pink flowers develop in the axils of the leaves. The flowers turn cream yellow as they age. The small shiny globular fruits turn from green to black as they ripen. Each fruit contains 2–3 small brown to black ovate seeds. *Lonicera japonica* invades a wide variety of habitats including forest floors, canopies, roadsides, wetlands, and disturbed areas. It can girdle small saplings by twining around them and can form dense mats in the canopies of trees, shading everything below. A native of eastern Asia, it was first introduced into North America in 1806 in Long Island, NY. *Lonicera japonica* has been planted widely throughout the United States as an ornamental, for erosion control, and for wildlife habitat. (CISEH 2022bo)

Kudzu (Pueraria montana var. lobata)

Pueraria montana var. lobata is a climbing, deciduous vine capable of reaching lengths of over 100 feet (30.5 meters) in a single season. Its fleshy tap roots can reach 7 inches (18 centimeters) in width and grow to 9 feet (3.8 meters) deep. These roots can weigh up to 400 pounds or (180 kg). Leaves are alternate, compound (with three, usually lobed, leaflets), hairy underneath and up to 5.4 inches (15 centimeters) long. Flowering occurs in midsummer, when 0.5 inches (1.3 centimeters) long, purple, fragrant flowers hang, in clusters, in the axils of the leaves. Fruit is brown, hairy, flat, 3 inches (7.6 centimeters) long, 0.3 inches. (0.8 centimeters) wide seed pods. Each pod can contain three to 10 hard seeds. Preferred habitat includes open, disturbed areas such as roadsides, ROW, forest edges, and old fields. *Pueraria montana var. lobata* often grows over, shades out and kills all other vegetation, including trees. It is native to Asia and was first introduced into the United States in 1876 at the Philadelphia Centennial Exposition. It was widely planted throughout the eastern half of the United States (including Illinois) in an attempt to control erosion. (CISEH 2022bp)

Winter creeper (Euonymus fortunei)

Euonymus fortunei is an evergreen perennial vine that was introduced as an ornamental groundcover. It is native to China, Japan, and Korea. Leaves are opposite, glossy, dark green, oval, slightly toothed, with light-colored veins, about 1-2.5 inches (2.5-6.4 centimeters) long. Flowers are small and greenish with five petals on long branched stalks. Fruits are small round pink-red capsules that split open to expose seeds with red-orange arils. *Euonymus fortunei* is a vigorous vine that invades forest openings and margins. It grows across the ground, displacing herbaceous plants and seedlings and climbs trees high into the tree canopy by clinging to the bark. Forest openings, caused by wind, insects or fire are especially vulnerable to invasion. *Euonymus fortunei* has been reported to be invasive in natural areas in most of the states in the eastern half of the United States. It can tolerate a broad range of environmental conditions ranging from full sun to deep shade, and acidic to basic and low nutrient soils, but it does not grow well in heavy wet soils. Look-alikes are the native Partridge berry *(Mitchella repens*) and the invasive Japanese honeysuckle (*Lonicera japonica*) and common periwinkle (*Vinca minor*). (CISEH 2022bq)

3.7.5.4 Invasive Terrestrial Animals

Feral swine (Sus scrofa)

Feral swine (also called wild pigs and feral hogs) are an invasive species rapidly becoming established throughout the country. Feral swine cause significant damage to agricultural crops, forests, private property, and other natural areas. In 2000, it was estimated that the total damage caused by feral swine in the United States was approximately $800 million annually. Feral swine damage is caused by their feeding, wallowing, rooting, and tree rubbing. Damage usually occurs at night and can be severe after only a few nights. Damaged areas are left exposed and open to the establishment of invasive plants. Feral swine can vary greatly in appearance and in size. Feral swine are a cross between the Eurasian boar and escaped/neglected domestic swine. Typical fur coloration for true Eurasian boar can be grey to dark brown to black, while domestic breeds can display a wider variety of colors with many defining patterns of striping or spots. Feral swine can carry diseases that threaten livestock, pets, and humans. Feral swine are omnivorous feeders and will consume anything in their path – invertebrates, small mammals and other small vertebrates, eggs of ground-nesting birds, even the young of larger animals such as white-tailed deer. In addition, feral swine compete with native wildlife for valuable resources, such as acorns that squirrels, deer, and turkey depend on during winter months. (CISEH 2023br)

Emerald ash borer (Agrilus planipennis)

The emerald ash borer is native to Asia and is believed to have been brought to the United States in wood packing materials as early as the 1990s. The first beetle was discovered in the United States in Michigan in 2002. Since 2002, it has spread to 23 states and killed over 25 million ash trees. Much of the spread throughout the United States is from people moving firewood cut from infested trees. Adult emerald ash borers are a metallic emerald green and are approximately 7.5−15 millimeters long. The beetles will feed on leaves of the ash tree, but the main damage to the trees is the done by larvae feeding on the inner bark. All native ash trees in the United States have been found to be susceptible to emerald ash borer infestations. Adults are active from May to the beginning of September and are most active on sunny days when temperatures are above 77°F. Males live for an average of 7 weeks, while females live on average for 9 weeks. Females prefer to lay eggs on ash trees that are in open areas or on the edges of forests and will slowly move to more interior trees as the outer trees die from the infestation. Eggs are laid in cracks and crevices in the bark of the trunk, branches, and exposed roots. Once the larvae hatch after 7 to 10 days, they chew a path into the inner bark and outer sapwood. This is where tree nutrients are supported. Larvae will overwinter in the ash trees and emerge the following spring or early summer. They chew their way out and widen the tunnels they made moving to the interior of the tree. The adults emerge from a “D”-shaped hole, and once emerged they subsist on the ash leaves. Once trees become infested with emerald ash borers, they die within 1−3 years. (Chamorro et al. 2015; USDA 2020)

Asian longhorned beetle (Anoplophora glabripennis)

Asian longhorned beetle, *Anoplophora glabripennis Motschulsky*, is native to Asia (principally China) and invasive in parts of western Europe, and in several American cities, where eradication efforts are underway. This borer attacks a variety of hardwood trees. In China, Asian longhorned beetles are not damaging in forests, but because of extensive planting of certain poplars (exotic varieties) that proved highly susceptible to the species, the insect increased in abundance. This action facilitated the beetle’s dissemination to other countries because infested wood was used for packing material. In southern Asia, a generation requires 1 year, but in northern areas, 2 years are required. Generations may be overlapping. Unlike many cerambycids, *A. glabripennis* attacks healthy trees as well as those under stress. Several generations can develop within an individual tree, eventually killing it. Adults emerge over an extended period from spring to fall, but especially in late June to early July. Adults remain on or near their emergence tree and engage in maturation feeding on leaves, petioles, and tender bark. Eggs are laid singly under the bark, in egg sites chewed by females. Larvae feed in the cambium layer of the tree and later into the heartwood. Larvae dig pupation chambers inside the tree, which can be filled with frass. Adults emerge via large 0.4 inches (1 centimeter) diameter round exit holes, which are a visible sign of infestation. (CISEH 2022bs)

Gypsy moth (Lymantria dispar)

The gypsy moth was introduced to the United States from western Europe in 1869. Adult male moths are a light brownish-yellow and are diurnal. Female moths are white with wavy black markings and cannot fly. Caterpillars are approximately 2 inches long with yellow and black heads. They are hairy and have five pairs of blue spots followed by six pairs of red spots on their back. Masses of 400-600 eggs are laid on various substrates such as trees and stones. The eggs overwinter and hatch in early spring. The larvae that hatch from the eggs can be dispersed by wind. Larvae will eat the leaves of trees all day and night until they are half grown, and they then become nocturnal. The preferred host trees for gypsy moths include alder, aspen, gray birch, white birch, hawthorn, larch, linden, mountain ash, oaks, willow, and witch-hazel. Tree mortality is often due to defoliation multiple years in a row. (Hoover 2022)

3.7.6 Procedures and Protocols

CPS relies on administrative controls and other regulatory programs to ensure habitats and wildlife are protected as a result of a change in station operations (e.g., water withdrawal increase, new NPDES discharge point, wastewater discharge increase, air emissions increase), or prior to ground-disturbing activities. The administrative controls, as discussed in Section 9.5, involve reviewing the change, identifying effects, if any, on the environmental resource area (e.g., habitat and wildlife), establishing BMPs, modifying existing permits, or acquiring new permits as needed to minimize impacts. Existing regulatory programs that the site is subject to, as presented in Chapter 9, also ensure that habitats and wildlife are protected. These are related to programs such as the following: stormwater management for controlling the runoff of pollution sources such as sediment, metals, or chemicals; spill prevention to ensure that BMPs and structural controls are in place to minimize the potential for a chemical release to the environment; bird nest removal; and management of herbicide applications to ensure that the intended use would not adversely affect the environment.

3.7.7 Studies and Monitoring

3.7.7.1 Impingement and Entrainment Monitoring

Monitoring of impingement and entrainment of fish and aquatic species has been conducted at CPS. The current NPDES permit was issued on March 31, 2020, modified on May 3, 2021, and is valid through March 31, 2025. As discussed within Special Condition 10 of the current NPDES permit, the IEPA has determined that the operation of the cooling lake meets the Best Technology Available (BTA) for impingement mortality, as defined under 40 CFR 125.94(c)(1). Based on available information at the time of permit reissuance, IEPA has determined that the operation of the cooling water intake structure meets the equivalent of BTA for entrainment in accordance with the Best Professional Judgement provisions of 40 CFR 125.90(b) and 125.98(b)(5). As part of the permit, the IEPA requested an entrainment characterization study be conducted with the results of the study provided to IEPA to make a final BTA determination for entrainment, which is expected as part of the next NPDES permit.

Therefore, an entrainment abundance characterization study was conducted at CPS between 2019 and 2020. Two impingement studies have taken place at CPS: the first one was conducted between May 1987–April 1988, and the second was conducted from April 2005 to March 2007. These studies are summarized below.

3.7.7.1.1 2019 and 2020 Entrainment Abundance Characterization Study

The objective of the entrainment abundance study was to estimate total annual entrainment due to the operation of Unit 1 at CPS under actual intake flow (AIF) and design intake flow (DIF) scenarios. The estimates were based on entrainment data collected weekly during a seven-month period in 2019 (March 18 through September 23) and a 6-month period in 2020 (April 16 through September 28). Twenty-eight separate 24-hour sampling events were conducted in 2019 and 25 sampling events were conducted in 2020. Sampling in 2020 was reduced due to the COVID-19 virus pandemic that prohibited the first three weeks of sampling. Each 24-hour event was divided into two 12-hour sample periods (day and night). The entrainment data collected is expressed herein as organism densities (number/volume) and then multiplied by volumes of cooling water pumped in order to estimate the numbers of organisms entrained under AIF and DIF scenarios for Unit 1.

A combined total of 4,611 organisms (4,602 finfish and 9 mollusks) were collected during 2019 and 2020 entrainment sampling at CPS: 2,892 organisms (2,885 finfish and 7 mollusks) were collected during 2019, and 1,719 organisms (1,717 finfish and 2 mollusks) were collected during 2020. Finfish were distributed among six distinct taxa and mollusks from one distinct taxon. Mollusks comprised <1.0 percent of the total entrainment during each year, with finfish contributing >99.0 percent. Overall, the entrainment composition collected in 2019 and 2020 at CPS is consistent with impingement and adult and juvenile data collected at Clinton Lake since the 1980s. No threatened or endangered species of finfish or unionid mussels were collected in 2019 or 2020.

Gizzard shad (*Dorosoma cepedianum*) was the most abundant finfish species collected during 2019 and 2020. Gizzard shad post yolk-sac larvae accounted for 85.8 percent of all finfish collected during the 2-year study and gizzard shad yolk-sac larvae accounted for 2.3 percent of the finfish collected. Gizzard shad is one of several species considered a "fragile species" as defined in the CWA Final 316(b) Rule for Existing Facilities, effective October 14, 2014, (§316(b) Final Rule), Section 125.92(m). The EPA defines "fragile species" as a species of fish or shellfish that has an impingement survival rate of less than 30 percent. Freshwater drum (*Aplodinotus grunniens*) was the second most common finfish species collected, accounting for 7.2 percent of finfish community over the 2-year study, with eggs contributing 6.8 percent to the total finfish entrainment collections, with yolk-sac and post yolk-sac larvae accounting for 0.2 percent each. Common sunfishes (*Lepomis* spp.) and crappie (*Pomoxis* spp.) were only collected as post yolk-sac larvae and accounted for 2.2 percent and 1.4 percent of all finfish collected. Sunfish (Centrarchidae) were collected as post yolk-sac larvae (0.2 percent), common carp (*Cyprinus carpio*) were collected as yolk-sac and post-yolk sac larvae (0.1 percent) and quillbacks/carpsuckers (*Carpiodes* spp.) were collected only as post-yolk sac larvae (0.1 percent). Fingernail clam (*Pisidium* spp.) juveniles accounted for 0.2 percent of the total entrainment collections.

No finfish were collected during the first four sampling dates (March 18 through April 8, 2019), suggesting that the entrainment sampling program encompassed the entire entrainment season. Similar results were noted in 2020, when sampling was delayed due to COVID-19. The peak mean sample densities of the four most abundant finfish taxa (gizzard shad, freshwater drum, common sunfishes, and crappie) occurred during the months of May and June. Gizzard shad post yolk-sac larvae occurred in the highest sample densities of all taxa in May (163.1/100 m^3) and freshwater drum eggs occurred in the second highest sample densities of all taxa in June (13.2/100 m^3). Crappie (2.2/100 m^3) and common sunfishes (2.8/100 m^3), all collected as post yolk-sac larvae, occurred in the highest densities in May and June 2020, respectively.

Gizzard shad and freshwater drum yolk-sac larvae were collected in the highest densities in June.

The estimated number of organisms entrained annually at CPS under AIF was 312,634,760 using 2019 AIF and 2019 densities, and 166,454,271 using 2020 AIF and 2020 densities. The estimated combined average number of organisms entrained using the 2019 and 2020 average AIF and entrainment densities was 242,798,485. Gizzard shad was the most common taxa entrained, comprising 262,920,238 of the total organisms entrained under 2019 AIF, and 156,802,344 under 2020 AIF, which comprised 87 percent of all entrained finfish over the 2 years.

The projected number of organisms that would be entrained annually under the DIF full flow scenario at CPS is estimated to be 387,670,375 using the 2019 entrainment density, and 210,991,559 using the 2020 entrainment density. The projected annual entrainment under DIF using 2019 and 2020 average densities at CPS is estimated to be 301,584,200. Although the estimated number of entrained finfish at CPS during this study is in the millions, natural mortality of fish eggs and larvae is very high with few eggs and larvae surviving to the juvenile or adult life stage. Survival rates from egg to adult vary by species, according to size, predation, cannibalism, disease, competition, location, physicochemical factors, habitat, etc. Average survival for freshwater fish from viable egg to adult is typically less than 5 percent.

Clinton Lake was formed by construction of an earthen dam across Salt Creek to serve as an impoundment and heat sink for the CPS closed-cycle cooling water system. Make-up water and blow down flows are supplied to the closed cycle recirculating system via the CWIS. The §316(b) Final Rule does not identify specific technological alternatives for achieving compliance with the Best Technology Available (BTA) Standard for Entrainment but provides that the BTA determination is to be made on a case-by-case basis by the permitting authority. In the §316(b) Final Rule, EPA concludes that "closed cycle recirculating systems reduce entrainment (and impingement mortality) to the greatest extent and are the most effective performing technology." Thus, the best professional judgement determination that the CPS closed cycle recirculating system is BTA for preventing and minimizing entrainment impacts is entirely consistent with, and supported by, the §316(b) Final Rule. Additionally, fish stocking efforts have been an integral part of the fish management program at Clinton Lake since its creation. This aligns with the requirements of 40 CFR §125.95(a)(3) where the permitting authorities can waive some or all of the requirements of 40 CFR §122.21(r) because Clinton Lake does not include any threatened or endangered species and it is highly stocked and managed by IDNR.

3.7.7.1.2 1987–1988 Impingement Study

The first impingement sampling at Clinton Lake was conducted between May 1987 and April 1988. Sampling was conducted over a 24-hour period once every two weeks. Eight taxa were collected over 84 sampling days. Impingement was dominated by gizzard shad (99.9 percent). The majority of impinged gizzard shad were young-of-the-year (YOY) individuals. Gizzard shad impingement occurred year-round but began to significantly increase in late fall when water temperatures decreased. Impingement peaked between December and March when water temperatures fell between 4 degrees Celsius (°C) and 6°C. Gizzard shad impingement ended abruptly in the spring when water temperatures began to rise.

Gizzard shad have high mortality rates when water temperatures begin to decrease in the fall and remain cold throughout the winter. YOY shad have a high mortality rate during this period, which may be as high as 99.9 percent. The shad become disoriented and distressed when water temperatures reach 6ºC to 7ºC and suffer mortality when temperatures decrease to 3ºC or 4ºC. Peak impingement at CPS correlates with low water temperatures, as the average water temperatures for December and January were 4ºC and 6ºC for February and March. Therefore, impinged gizzard shad were mostly moribund. In promulgating the Existing Facilities Rule, EPA excluded fish that were dead at time zero from the calculation of latent impingement mortality because those counts did not measure mortal harm caused by impingement and may "reflect already injured, nearly dead, or already dead fish ('naturally moribund') that were impinged by the screen." Since the majority of overall impingement at CPS is gizzard shad during winter months, very little impingement mortality is related to operation of the CWIS.

In addition to gizzard shad, three species had a total estimated impingement between May 1987 and April 1988 over 100 individuals: white crappie, freshwater drum, and black bullhead. White crappie (2,338 individuals) was impinged between April and October, with peak impingement in August (791 individuals). Freshwater drum (758 individuals) was impinged between March and November, with peaks in impingement in April (196 individuals) and October (155 individuals). Black bullhead (148 individuals) was only impinged in May and July through September, peaking in September (70 individuals).

3.7.7.1.3 2005–2007 Impingement Monitoring Study

The most recent impingement characterization study at CPS took place between April 5, 2005, and March 29, 2007. Samples were collected over a 24-hour period weekly. Two samples were taken in the event that the impinged number of fish exceeded 5,000, included more than 25 individuals of an important game species, or when researchers deemed it necessary. Sampling from April 2005 through March 2007 recorded increases in impingement as water temperatures began to fall.

An estimated 615,278 fish, representing eight families, were impinged during the first year (April 2005−March 2006) of impingement sampling. Gizzard shad impingement composition was 91.8 percent. Other top impinged species were freshwater drum (5.5 percent), bluegill (1.5 percent), white bass (0.3 percent), and black crappie (0.2 percent). Green sunfish (0.2 percent) were impinged in slightly greater numbers than black crappie, but 95 percent of their impingement was attributed to a single severe weather event in March 2006. Biomass impinged was estimated to be 12,469 kg impinged during the first year. Gizzard shad accounted for 73.5 percent composition, followed by freshwater drum (16.1 percent), white bass (3.6 percent), hybrid striped bass (2.4 percent), and bluegill (1.2 percent). The only shellfish impinged were unidentified species of crayfish.

Survival and diel periodicity samples from the first year of impingement sampling collected 21,565 fish, representing 19 taxa and 8 families. Survival and diel sampling occurred concurrently monthly over a 24-hour period. Samples were collected once every 2 hours. Live fish were held in a 500-gallon recirculation tank over a 24-hour period. Most of the fish collected were dead or moribund at the time of impingement.

Survival testing could only be conducted on 386 fish. Sixty fish survived over the 24-hour holding period. The survival rate was 0.28 percent. This reflects that impingement at CPS is primarily passive as approximately 98 percent of fish impinged were considered dead or moribund. Projections estimated 2,515 out of 615,278 impinged individuals to survive 24 hours after impingement. Survival and diel sampling were discontinued after 1 year of sampling after consultations with the IEPA.

An estimated 16,757,647 fish, representing eight families, were impinged during the second year (April 2006−March 2007) of sampling. Gizzard shad accounted for 99.9 percent of impingement. The remaining 0.1 percent (15,424 fish) impinged were composed of bluegill, freshwater drum, black crappie, white bass, orange spotted sunfish, and green sunfish. An estimated 79,058 kg were impinged during the second year. Gizzard shad dominated biomass composition at 98.7 percent, followed by black crappie (0.4 percent), freshwater drum (0.4 percent), white bass (0.2 percent), and bluegill (0.1 percent). Impingement frequency was not directly proportional to species' abundance observed from fish community samples. Three of the five most abundant species from community surveys differed from the five most frequently collected species from impingement sampling.

During the first year of the impingement study, three major impingement episodes occurred that accounted for 26.5 percent of the first year's total raw impingement numbers. The vast majority of impingement during these events was composed of gizzard shad. The events occurred on September 26, November 1, and March 7. Peak impingement occurred in March, with an estimated 180,937 fish, which accounts for 31 percent of the estimated annual impingement. March, November, and October accounted for 70.3 percent of the estimated annual impingement. Impingement was lowest in May, with an estimated 1,456 fish impinged, accounting for 0.3 percent of the estimated annual impingement. Impingement remained low from June through August.

It was concluded that sampling results from March 14, 2005, were likely uncharacteristic of impingement at CPS because extreme thunderstorms occurred two days prior to sampling. During this sampling event, five species were impinged for the first time and five other impinged species were considered uncommon in previous samples. This included YOY carp, bluegill, and green sunfish, which were not normally found in previous samples. Given that many of the impinged fish were typical stream species and were absent from subsequent collections, it is believed they were displaced from the watershed and into Clinton Lake during the storm. Large storm events in the future may cause impingement of species that are not representative of typical impingement at CPS.

The first major impingement episode in the second year of impingement sampling occurred in early October, involving juvenile gizzard shad. Impingement increased into the winter months and peaked in February, accounting for 45.7 percent of the estimated annual impingement. Impingement from January through March accounted for approximately 80 percent of the annual estimated impingement for year two. Impingement was lowest in May and June, with 1,586 and 1,830 fish impinged, respectively.

Similar results occurred in previous impingement sampling from 1987 through 1988. Gizzard shad composed of over 99 percent of impingement. Gizzard shad impingement began in the late fall as temperatures began to decline and peaked between December and March when water temperatures in Clinton Lake were between 39°F to 43°F. Gizzard shad impingement ended abruptly in the spring as the water warmed. Impinged gizzard shad were primarily YOY individuals and showed the effects of cold stress.

Diel sampling occurred concurrently with survival studies once per month over a 24-hour period. During each sampling event, samples were collected once every two hours. No distinct diel patterns were identified as the majority of impingement were dead or moribund gizzard shad. The only diel trend observed was that bluegill impingement in the second and third quarter was slightly lower during late night hours and higher during the early afternoon. Diel sampling was discontinued after the first year following consultation with the IEPA.

Impingement at CPS appeared to be primarily driven by seasonal patterns, rather than diel behavior. Impingement events were primarily driven by decreases in water temperature, and gizzard shad mortality due to cold temperatures. As water temperatures warmed in the spring, impingement rates significantly decreased. Periods of impingement of white bass and black crappie in Clinton Lake were attributed to severe fungal infections that occurred in the fall of 2005 and winter of 2006. Certain seasonal conditions in the lake may trigger fungal growth and increase infection rates within the lake, resulting in increased impingement of susceptible species. Storm events, as observed in March 2005, may result in high flows and the flushing of fish from the North Fork of Salt Creek into Clinton Lake. High flow, stress, and turbidity could result in impingement events of atypical species, such as those observed on March 14, 2005, when high numbers of green sunfish were impinged.

3.7.7.1.4 Historical Fish Community Studies at Clinton Lake

Numerous studies have been conducted to describe the fish community in Clinton Lake. The IDNR conducted fall fish population surveys and other species studies at Clinton Lake from 1979 to the present. IDNR studies of Clinton Lake have focused on key sport fish species including, walleye (*Sander vitreus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), channel catfish (*Ictalurus punctatus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), blacknose crappie (a morphological variant of Black Crappie), white bass (*Marone chrysops*), and hybrid striped bass (*Marone chrysops x Marone saxatilis*). Several metrics have been used by IDNR to evaluate the status of these species, including catch per effort (CPE), proportional stock density, relative stock density, and relative weight. Total numbers of fish collected by electrofishing location and sampling year have been tabulated and summarized by IDNR since 1982. These data include minnows, suckers, bullheads, and other species that have been captured concurrently with the targeted sport fish. No state or federal listed aquatic species have ever been collected in Clinton Lake.

IDNR has described largemouth bass, walleye, black crappie/blacknose crappie, and hybrid striped bass as being common to relatively abundant in Clinton Lake during recent surveys. The walleye, blacknose crappie, blue catfish (*Urus furcatus*), and hybrid striped bass fisheries are dependent upon stocking programs conducted by IDNR and CEG. Fish stocking have been an integral part of the fish management program at Clinton Lake since its creation. This aligns with the requirements of 40 CFR §125.95(a)(3) where the permitting authorities can waive some or all of the requirements of 40 CFR §122.21(r) because this manmade lake is stocked and highly managed by IDNR.

The tiger muskellunge (*Esox odali x masquinongy*) and smallmouth bass stocking efforts that had been conducted in Clinton Lake did not meet the stocking objectives established by IDNR and for that reason they have been discontinued. White crappie were relatively abundant in Clinton Lake during the early 1990s until their abundance began to fall sharply to an all-time low in 2004. CPE of this species remained low until 2011 when catch rates began to increase. CPE for this species in 2018 was the highest reported since 1995. The largest portions of these fish have been collected in the North Fork arm of the lake. Largemouth bass catch rate has also exhibited an increasing trend during most years since 2008. Electrofishing surveys and impingement studies indicate that gizzard shad are very abundant in Clinton Lake with catches of this species being highly variable by location and from survey to survey.

IPC conducted an EMP from 1978 to 1991 that included fisheries-related studies. IPC also conducted creel surveys from 1982 through 1989. A report published by Environmental Science & Engineering Inc. described some of the first studies conducted at Clinton Lake. Fish species commonly encountered included gizzard shad, common carp, bluegill (*Lepomis macrochirus*), white crappie, channel catfish (*Ictalurus punctatus*), and largemouth bass. Additional sport fish such as tiger muskellunge, hybrid striped bass, walleye, black crappie, green sunfish (*Lepomis cyanelus*), flathead catfish (*Pylodictis olivaris*), and smallmouth bass were either relatively common or occasionally encountered. Non sport fish species encountered on a regular basis included bigmouth buffalo (*Ictiobus cyprinellus*), quillback (*Carpiodes vyprinus*), shorthead redhorse (*Moxostoma macrolepidotum*), and freshwater drum. During the early EMP studies, six representative important species, gizzard shad, common carp, channel catfish, bluegill, largemouth bass, and white crappie, were selected for additional evaluation regarding thermal tolerance for adult survival, growth, spawning, and embryo survival.

Thirty-three species, including two hybrids (hybrid striped bass and tiger muskellunge) of fish were collected by IPC at Clinton Lake during 1983−1986 (pre-operational data) and 1987−1991. Five species comprised 93 percent of the numerical catch during 1987−1991, with gizzard shad being the most abundant fish collected, followed by bluegill, white crappie, common carp, and largemouth bass. Biomass during that same time period was dominated by common carp, gizzard shad, largemouth bass, white crappie, bigmouth buffalo, quillback, and walleye.

Electrofishing, beach seining, and gill netting was used during studies conducted at Clinton Lake from 2005 through 2007 by Strategic Environmental Actions, Inc. Relative abundance of species collected in impingement sampling at the CPS intake during the same time period did not appear to be strongly correlated with species' abundance in the lake samples. Three of the five most abundant species collected in the lake samples were different than the five most frequently collected species in impingement samples. The five most abundant species collected in the lake, gizzard shad, bluegill, largemouth bass, common carp, and green sunfish, were the same both years. Numerically, these five species comprised 89.7 percent and 92.9 percent of all fish captured from April 2005 to March 2006 and April 2006 to March 2007, respectively. In comparison, largemouth bass and common carp were rare or absent in impingement samples. Green sunfish were impinged during a few isolated episodes but were generally not common in most samples. Freshwater drum were common in impingement samples but less abundant in lake samples.

A survey of adult and juvenile fish populations in Clinton Lake was conducted using electrofishing and beach seines during four separate "quarterly" sampling events in April, July, September, and November 2015 for CPS as part of a Section 316(a) Variance Demonstration study plan. Community metrics of relative abundance, species richness, CPE, Shannon-Wiener Diversity Index, relative weight, percent non-indigenous taxa, deformities, eroded fins, lesions, tumors, anomalies, and species length-frequency distributions were calculated from the survey results. Although Clinton Lake was artificially created to accommodate cooling water requirements for CPS, the lake is heavily managed through stocking efforts and habitat enhancements. Additionally, no commercial fishing contracts are being utilized to further manage rough fish species (common carp, Asian carp, bigmouth buffalo) in Clinton Lake. The metrics listed above taken as a whole indicate that a balanced indigenous community (BIC) of fish was present throughout Clinton Lake in 2015.

Studies that have been conducted at Clinton Lake beginning in 1978 indicate that the fish community has undergone changes. The abundance of gizzard shad has decreased from levels observed during the first impingement study conducted from May 1987 to April 1988, but this species is still very abundant in the lake (IPC 1988b). White crappie abundance has experienced a greater decline than gizzard shad, while abundances of black crappie and white bass have increased. The numerous studies conducted by IDNR and consultants for CPS indicate that a variety of species are present in the lake waters surrounding CPS, namely, in order of general prevalence, gizzard shad, bluegill, common carp, largemouth bass, green sunfish, freshwater drum, channel catfish, black crappie/blacknose crappie, white bass, and hybrid striped bass. A total of at least 33 fish taxa have been collected during these studies demonstrating a stable indigenous community. No threatened or endangered species have ever been collected in Clinton Lake.

Results of past and recent fish surveys at Clinton Lake continue to show that a BIC of fish is present in the areas of influence near the CPS intake and discharge, as well as in the cooling loop of the lake, and in the North Fork arm located outside of the Station's thermal influence. Current operating conditions at CPS do not appear to have had any detectable effect on fish communities in Clinton Lake, and there is no evidence that past operations have resulted in any appreciable harm to the BIC in the vicinity of the Station or in other portions of Clinton Lake.

3.7.7.1.5 Thermal Studies

A thermal modelling study was conducted in 2015 and submitted in 2016 as part of CPS's permit renewal application in fulfillment of requirements of Ill. Adm. Code, Section 106.1180. As required under Ill. Adm. Code, Section 106.1180, this 316(a) demonstration study showed that the nature of the thermal discharge had not changed since the alternate thermal limits were granted and that the alternative thermal effluent limitation granted by the Illinois Pollution Control Board did not cause appreciable harm to Clinton Lake's BIC of shellfish, fish and wildlife.

Thermal field surveys of temperature and other relevant parameters within Clinton Lake were conducted in mid-July to mid-September 2015, in order to characterize CPS's plume. The lake temperature monitoring program was designed to delineate the extent of CPS's thermal plume both spatially and temporally during periods of critical river conditions with CPS operating at or near full capacity. This program provided the data needed to map the thermal extent of the discharge and to support development of a hydrothermal model of Clinton Lake. The hydrothermal model allowed additional flexibility in assessing the potential impacts of CPS's thermal discharge over a range of lake and operating conditions that may not have been captured by the temperature monitoring program.

Details of the survey sampling locations, the survey calendar periods, sampling frequency, and station operations during the survey period, follow.

CPS's thermal discharge was mapped based on temperatures collected during two mobile boat surveys and by strings of thermistors deployed on fixed moorings distributed throughout the lake. The mobile and fixed-location temperature surveys were performed from mid-July to mid-September 2015. Fixed temperature monitoring covered the entire area from the North Branch of Clinton Lake at the North Fork Bridge upstream of CPS's intake to the spillway and from Salt Creek at the Liberty Road Bridge upstream of CPS's discharge to the Spillway. In addition to the boat surveys, a total of 23 fixed temperature moorings were deployed within the study area. These thermistor strings continuously monitored temperature during the 2-month deployment period from the week of July 13 to September 14, 2015. Continuous collections by the meters captured variations in lake temperatures due to changes in air temperature, lake surface elevation and flow and other influences.

A hydrothermal model was developed using existing information, data obtained from the lake temperature surveys in 2015 and data from other sources. A MIKE-3D Flow Model FM was used to perform the hydrothermal modeling as this model is capable of calculating thermal conditions in the near-field as the plume enters the lake and then in the far-field as the plume disperses further into the lake. The model used was a three-dimensional model that included the following key physical processes: power plant operating conditions (intake and discharge flows and associated thermal load), lake flow, lake elevation and temperature dynamics, and atmospheric forcing mechanisms such as heating, cooling and wind stress.

The MIKE-3D model was applied to project near-field and far-field temperatures in CPS's discharge plume under critical conditions. Critical conditions are intended to represent worst case or extreme scenarios which are typically used to evaluate compliance with state water quality standards. The projection run simulates the spatial extent (area) of the thermal plume under these extreme conditions. Critical conditions for the projection run include lake elevation at the 10th percentile of historical values, air temperature at the 90th percentile of historic values and CPS's discharge at permitted flow and at full heat load. A review of available data from 2002 to 2015 indicated that July and August of 2012 had the lowest elevations and highest air temperatures. The year 2012 was also a drought year, with drought conditions classified as severe to extreme during July and August, as reported by the Illinois Drought Response Task Force. Hence, July and August 2012 conditions were selected as representative of the extreme case.

Absolute Maximum Clinton Lake Temperature

During the critical case simulation, the warmest lake water temperatures occurred on July 18, 2015. The one-day (daily average) temperature at the second drop structure is 108.1°F. Surface one day lake temperatures up to 108°F are predicted within 0.20 miles upstream and 0.50 miles downstream of the discharge and laterally across Salt Creek. These temperatures dissipate to less than 105°F 1.2 miles downstream of the discharge and less than 100°F 3.3 miles upstream of the discharge. One day surface temperatures are less than 90°F approximately 5.0 miles downstream of the discharge, including at the Spillway, and through the UHS. The maximum one-day average at the spillway in the worst-case projection run was 83.1°F on July 18, 2015, which was the warmest day. The thermal plume exhibits vertical stratification at the discharge and within the area bounded by the Route 14 and Route 48 bridges. The thermal plume maintains stratification while migrating below the Route 14 Bridge with little stratification at and beyond the Spillway Dam.

Compliance with 90°F Maximum in Salt Creek below the Spillway

As mentioned above, under worse case conditions, predicted temperatures of lake waters are less than 90°F at the Spillway. Given that this is a worst-case scenario, it can be assumed that discharges to Salt Creek below the spillway would not exceed 90°F under other less extreme conditions.

Clinton Lake Temperature Change from Ambient

A model simulation, without CPS's discharge, but with all other conditions the same as in the worst-case projection simulation, was completed to simulate ambient conditions without CPS's discharge. Hourly differences in temperature between the with and without station projection runs were calculated. Lake temperature change due to CPS's discharge, in the vicinity of the discharge, is on the order of 27.5°F to 32.5°F. Excess temperatures decline moving upstream and downstream of the discharge. Excess temperatures are less than 7.5°F at the spillway and continue to decline approaching the UHS. The one-day average excess temperature at the intake on July 18, 2015, is 5.0°F (2.8°C).

3.7.7.1.6 CPS Snake Monitoring and Conservation Plan

In 2019, a transect survey was conducted in partnership with the Illinois Natural History Survey Prairie Research Institute at University of Illinois, Urbana-Champaign, to determine demographic information and presence/absence of Kirtland's snake. This project, initiated by the University of Illinois and conducted on property owned and maintained by CPS, aimed to minimize breeding season interference while maintaining optimal habitat conditions for the Kirtland's snake (*Clonophis kirtlandii*). The survey placed a total of 200 carpet squares divided equally between two study locations on CPS property south of Clinton Lake. The squares were monitored 18 times in 2019 with a total of four snake species were identified. These included: brown snake (*Storeria dekayi*), common garter snake (*Thamnophis sirtalis*), prairie kingsnake (*Lampropeltis calligaster*), and Kirtland's snake (*Clonophis kirtlandii*). A total of five Kirtland snakes were observed. A breeding population of Kirtland's Snake was identified as indicated with the identification of male, female, and juvenile individuals during the 2019 survey. In 2020, due to COVID-19 and staffing issues within the Illinois Natural History Survey Prairie Research Institute at University of Illinois, the snake transect monitoring study was not continued further.

3.7.8 Threatened, Endangered, and Protected Species, and Essential Fish Habitat

The USFWS maintains current lists of threatened and endangered species on its website (USFWS 2022a). The IDNR also maintains lists of state-protected species by county (IDNR 2022d). Species located onsite or potentially occurring within DeWitt County are listed as threatened or endangered by these agencies are described below and summarized in Table 3.7-5.

3.7.8.1 Federally Listed Species

A total of five federally listed endangered or threatened species were listed as possibly occurring within the 6-mile radius of CPS based on USFWS information for planning and consultation. No critical habitat for any species is listed within the 6-mile radius of CPS. (USFWS 2022a) Federally listed threatened or endangered species possibly occurring within a 6-mile radius of CPS include: Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), Eastern Massasauga rattlesnake (*Sistrurus catenatus*), rusty patched bumble bee (*Bombus affinis*), and eastern prairie fringed orchid (*Platanthera leucophaea*). Additionally, the monarch butterfly (*Danaus plexippus*) is federally listed as a candidate species (USFWS 2022c). Ecological descriptions and requirements for these species are summarized below. Compliance with all regulatory requirements associated with protected species would continue to be an administrative control practiced by CEG for the licensed life of the CPS facility. Adherence to these controls, as well as compliance with applicable laws and regulations should prevent potentially negative impacts to any special status and protected species.

3.7.8.1.1 Indiana Bat (Myotis Sodalis)

The Indiana bat is a federally endangered species that hibernates in caves and mines in winter. They are highly concentrated during hibernation, with 72 percent of the population hibernating in just four sites in Missouri, Indiana, and Illinois. The large winter colonies disperse in spring, and the bats migrate to summer habitats in wooded areas, where reproductive females form smaller maternity colonies. Males and non-reproductive females roost in trees but typically not in colonies. The range of the Indiana bat extends from the northeast through the east-central United States. The Indiana bat typically forages in semi-open forested habitats, forest edges, and riparian areas. Summer roosting habitat suitable for use by the Indiana bat requires dead, dying, or living trees of adequate size with sufficient exfoliating bark. Multiple roost sites may be used. Summer roosts typically are behind the bark of large, dead trees, particularly those that are in gaps in the forest canopy or along forest edges so that they receive sufficient sun exposure. Threats to the species include human disturbance of hibernating bats, commercialization of caves where the bats hibernate, loss of summer habitat, pesticides, and other contaminants, and most recently, the disease white-nose syndrome. The range-wide population has declined by 19 percent since 2007, when white-nose syndrome first arrived in North America. (USFWS 2022d)

The current known range for the Indiana bat overlaps with the CPS site (USFWS 2022d). Suitable roosting and maternity habitat for the species is present on the CPS site; however, no occurrences of Indiana bat have been documented within the immediate vicinity of the CPS site.

3.7.8.1.2 Northern Long-eared Bat (Myotis Septentrionalis)

The northern long-eared bat (*Myotis septentrionalis*) is federally listed as endangered. During the summer, northern long-eared bats use cavities under bark on both dead and live trees as well as mines and caves to roost. Females will roost in small colonies of 30 to 60 bats and on average give birth to one pup per female. During the winter, bats hibernate in small crevices and cracks in caves and mines that have constant temperatures, high humidity, and no air currents. Changes to any wintering site microclimates can make that habitat unsuitable for the bats. Threats to this species include white-nose syndrome, impacts to roost sites, loss of habitat, and wind farm operations. (USFWS 2022e)

The current known range for the northern long-eared bat overlaps with the CPS site (USFWS 2022e). Suitable roosting and maternity habitat for the northern long-eared bat is potentially present near the CPS site and the current known range for the species overlaps the CPS site (USFWS 2022e). No occurrence of northern long-eared bat have been documented in the vicinity of the CPS site.

3.7.8.1.3 Massasauga Rattlesnake (Sistrurus Catenatus)

Massasaugas are small snakes with thick bodies, heart-shaped heads, and vertical pupils. The average length of an adult is about 2 feet. Adult massasaugas are gray or light brown with large, light-edged chocolate brown blotches on the back and smaller blotches on the sides. The snake's belly is marbled dark gray or black and there is a narrow, white stripe on its head. Its tail has several dark brown rings and is tipped by gray-yellow horny rattles. Young snakes have the same markings but are more vividly colored. The head is a triangular shape, and the pupils are vertical. (USFWS 2022f)

Massasaugas live in wet areas including wet prairies, marshes and low areas along rivers and lakes. In many areas massasaugas also use adjacent uplands during part of the year. They often hibernate in crayfish burrows but may also be found under logs and tree roots or in small mammal burrows. Unlike other rattlesnakes, massasaugas hibernate alone. Lack of management and improper timing of management are threats to massasaugas. The snake's habitat requires vegetation control such as prescribed fire and mowing to prevent invasion of shrubs, trees, and non-native plants. Woody plant invasion is reducing the amount of available habitat in some areas. Where land is managed to prevent woody invasion, snakes may be killed by prescribed fire and mowing when it happens after snakes emerge from hibernation. (USFWS 2022f)

The species historical range included Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Wisconsin. (USFWS 2022f)

The current known range of this species does not overlap with the CPS site. No occurrence of massasauga rattlesnakes have been recorded in the vicinity of the CPS site. (USFWS 2022f)

3.7.8.1.4 Rusty patched Bumble Bee (Bombus Affinis)

The rusty patched bumble bee (*Bombus affinis*) is federally listed as endangered. This species lives in a variety of habitats, including prairies, woodlands, marshes, farms, parks, and gardens. Rusty patched bumble bees are habitat generalists but are typically found in areas that contain natural and semi-natural upland grassland, shrubland, woodlands, and forests. They may also be found in urban or suburban areas that contain nesting habitat, nectar and pollen resources, and overwintering habitat. In the spring they are often found in and near woodland habitats. Once found in 29 states and two Canadian provinces, its current range is limited to scattered locations within 10 states. (USFWS 2022g)

Suitable habitat for the rusty patched bumble bee is likely present in undeveloped portions of the CPS site that are not maintained by mowing; however, they may also use flowering plants in landscape features around the site if present. Additionally, suitable habitat is present in the vicinity of the CPS site, and according to USFWS data, the rusty patch bumble bee is considered likely to occur within 6 miles of the CPS site (USFWS 2022h).

3.7.8.1.5 Eastern Prairie Fringed Orchid (Platanthera Leucophaea)

The eastern prairie fringed orchid is federally listed as threatened. The species historical range included Arkansas, Illinois, Indiana, Iowa, Maine, Michigan, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Virginia, Wisconsin.

This plant is 8 to 40 inches tall and has an upright leafy stem with a flower cluster called an inflorescence. The 3-to-8-inch lance-shaped leaves sheath the stem. Each plant has one single flower spike composed of 5 to 40 white flowers. Each flower has a three-part fringed lip less than 1 inch long and a nectar spur (tube-like structure) which is about 1 to 2 inches long. The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetlands such as sedge meadows, marsh edges, even bogs. It requires full sun for optimum growth and flowering and a grassy habitat with little or no woody encroachment. A symbiotic relationship between the seed and soil fungus, called mycorrhizae, is necessary for seedlings to become established. This fungus helps the seeds assimilate nutrients in the soil. (USFWS 2022i)

The CPS site is within the current range of the eastern prairie fringed orchid and has suitable habitat for this species to occur. However, there have been no recorded occurrences of the species in the vicinity of the site.

3.7.8.1.6 Monarch Butterfly (Danaus Plexippus)

The Monarch butterfly (*Danaus plexippus*) is one of North America's most iconic insects. It's seen in backyards gardens and in highly urbanized locales. Monarchs live in fields and parks where milkweed and native plants are common.

Monarch butterflies migrate annually over long distances to overwinter as adults at forested locations in Mexico and California. The North American migratory populations account for more than 90 percent of the worldwide number of monarch butterflies. Overwintering sites provide protection from the elements (for example, rain, wind, hail, and excessive radiation) and moderate temperatures, as well as nectar and clean water sources. (USFWS 2022c)

Adult monarch butterflies feed on nectar from a wide variety of flowers. Reproduction is dependent on the presence of milkweed, the sole food source for larvae. The primary threats to the monarch's biological status include loss and degradation of habitat from conversion of grasslands to agriculture, widespread use of herbicides, logging and thinning at overwintering sites in Mexico, senescence, and incompatible management of overwintering sites in California, urban development, drought, exposure to insecticides, and the effects of climate change. (USFWS 2022c)

In December 2020, the USFWS found that listing the monarch butterfly as an endangered or threatened species is warranted but precluded by higher priority actions to amend the lists of endangered and threatened wildlife and plants. When a petitioned action is found to be warranted but precluded, the USFWS is required by the ESA to treat the petition as resubmitted on an annual basis until a proposal or withdrawal is published. Thus, the monarch butterfly is currently listed as a candidate species for protection under the ESA. (USFWS 2022c)

Suitable habitat for the monarch butterfly is likely present in undeveloped portions of the CPS site that are not maintained by mowing, in areas planted by the station as pollinator gardens (described in Section 3.7.2.6 above), as well as in the vicinity of the CPS site.

3.7.8.2 State Listed Species

A total of six plant and animal species are listed as potentially occurring in DeWitt Country, Illinois (IDNR 2022d). These species are discussed in more detail below:

3.7.8.2.1 Rusty Patched Bumble Bee (Bombus Affinis)

The rusty patched bumble bee is state listed as endangered (USFWS 2022h). As discussed above in Section 3.7.8.1.4, suitable habitat for the rusty patched bumble bee is likely present in undeveloped portions of the CPS site that are not maintained by mowing; however, they may also use flowering plants in landscape features around the site if present. Additionally, suitable habitat is present in the vicinity of the CPS site.

3.7.8.2.2 Northern Harrier (Circus Hudsonius)

The northern harrier is state listed as endangered. An adult northern harrier is 17−24 inches long. This hawk has a narrow body and wings and a long tail. There is a white-feathered patch at the base of the tail. The body of the male has gray feathers while the female has brown-and-cream, streaked feathers. The underside of the wing has a dark tip. The northern harrier is a common migrant and uncommon winter and summer resident in Illinois. It winters in Central and South America. The northern harrier lives in marshes or fields. This bird eats amphibians, birds, insects, mammals, and reptiles. It flies near the ground, gliding over an open field or marsh looking for food. The wings form a shallow "V" during flight. While migrating, the northern harrier flies alone. Its call is "pee, pee, pee." Spring migration begins in late February. Nesting occurs from May through July. The nest is built on the ground and is made of twigs and grasses. Two to five blue-white eggs are laid. Fall migrants begin appearing in July. Suitable habitat is potentially present in the vicinity of the CPS site. (IDNR 2020b)

3.7.8.2.3 Kirtland's Snake (Clonophis Kirtlandii)

Kirtland's snake is state listed as threatened. It is known from only a few scattered locations in the central and northeastern parts of the state. Its threatened status is mainly due to habitat loss from destruction and draining of prairie wetlands and reduction of earthworm populations due to pesticide use. This species averages between 14−18 inches in length and has a red belly with a row of round, black spots down each side. The body is gray or brown above, with four rows of black blotches that may be difficult to see. Kirtland's snake may be found in northeastern and central Illinois. This snake is aquatic, but it is often found on land. It lives in or near wet meadows, swamps, wooded hillsides, and adjacent meadows, parks, and urban areas. It can flatten its body when disturbed and hold this position for a long time. It hides under rocks, boards or in crayfish burrows during the day. Mating occurs in May. The female gives birth to four to 15 young in August or September. This snake eats earthworms, leeches, fishes, and slugs. (IDNR 2021)

As described in Section 3.7.7.1.6 above, a transect survey was conducted in 2019, south of the Salt Creek dam in the southern end of the CPS property, to determine demographic information and presence/absence of Kirtland's snake. This project, initiated by the University of Illinois, aimed to minimize breeding season interference while maintaining optimal habitat conditions for the Kirtland's snake on property owned and maintained by CPS. A total of five Kirtland's snakes were observed. A breeding population of Kirtland's snake was identified as indicated with the identification of male, female, and juvenile individuals during the 2019 survey.

3.7.8.2.4 Spike (Eurynia Dilatata)

The spike mussel is listed as endangered at the state level. The shell of the spike is elongated, moderately thick to heavy, compressed or slightly inflated, and up to 15 centimeters (6 inches) long. The outside of the shell is brown to black, occasionally with green rays. The beak sculpture consists of coarse loops raised slightly in the center. The pseudo cardinal and lateral teeth are well-developed, and the inner shell is usually purple, sometimes white or orange, or a combination. Spike mussels are usually found in small to large rivers, but they are also known to inhabit reservoirs and lakes. Whether in rivers or lakes, they are most often found in sand and gravel substrates in depths ranging from 0.6−7.3 meters. When spike mussels do inhabit lakes or reservoirs, they are usually associated with outlet habitats dominated by swift currents. Degradation of mussel habitat in streams throughout the spike's known range is a continuing threat. Spike populations are vulnerable to further decline because of hydrologic alteration of streams and their watersheds; the continuing decline in habitat conditions on the Mississippi River associated with its management as a navigation canal; and non-point and point source water pollution and sedimentation. Dams, channelization, and dredging increase siltation, physically alter habitat conditions, and block the movement of fish hosts. The spike mussel is also being impacted by the infestation of non-native zebra mussels in the Mississippi River and its tributaries. Zebra mussels can attach themselves in large numbers to the shells of native mussels, eventually causing death by suffocation. If current trends cannot be reversed, the spike may become threatened in the future. Further survey work in rivers where the spike mussel was formerly documented is needed to verify its status in that former range. (MNDNR 2022b) There is a potential for this species to be found in DeWitt County, but to date, there have been no recorded observations of this species in Clinton Lake.

3.7.8.2.5 American Brook Lamprey (Lethenteron Appendix)

The northern brook lamprey is threatened at the state-level. It is a non-parasitic lamprey reaching up to 6.3 inches in length. Adults are grayish brown dorsally, with a pale median line down the back, and lighter ventrally. The posterior portion of the tail is darker, almost black. Females tend to be slightly larger. The majority of its life, 3−6 years, is spent as a blind ammocoete, partially buried in sandy substrate. Ammocoetes feed on drifting, suspended, organic detritus, algae, and bacteria, or nutrients drawn from the surrounding sediment.

Transformation to adults occurs over 2−3 months in late summer or early fall. As adults, they do not feed, living instead off body fat reserves. Adults are typically found over coarse substrate, sand, or gravel; in swifter waters, riffles, or runs. Ammocoetes are found burrowed in fine sediment or organic debris, inside channels or other quiet water in areas with embedded woody debris. Spawning occurs in crevices beneath rocks and boulders. Decline is attributed to habitat degradation and incidental poisoning (IDNR 2022g). There is a potential for this species to be found in DeWitt County, but to date, there have been no recorded observations of this species in Clinton Lake or surrounding waterbodies around the site.

3.7.8.2.6 Monkeyface (Quadrula Metanevra)

Monkeyface mussels are listed as threatened in Illinois. This freshwater mussel species has a thick, rounded shell with knobs on the posterior ridge and an indentation on the posterior margin that appears like a profile of a chimpanzee, giving the monkeyface mussel its name. It can reach a length of 4 inches. The shell is green or light brown and has distinctive yellow zigzag/chevron markings. In older mussels, the shells may be darker, and the zig-zag markings may be missing. The nacre of the shell is a pearly iridescent white on the posterior side. The monkeyface mussel requires a host fish to complete its life cycle. Males release sperm into the water, which is taken up by females between March and July. Larvae, called glochidia, are released into the water where they must attach to a host fish. Confirmed host fish for monkeyface mussels include spotfin shiner (*Cyprinella spiloptera*), eastern blacknose dace (Rh*inichthys atratulus*), and creek chub (*Semotilus atromaculatus*), while reported hosts include bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and sauger (*Sander canadensis*). Glochidia remain on the host fish as they transform into their adult stage, and then they fall off. (NS 2022)

Monkeyface mussels can be found in medium and large rivers with clean water. They prefer substrate comprised of gravel or mixed sand and gravel and have been documented in the Manitowoc-Sheboygan watershed. Threats facing this species include pollution, habitat destruction, and competition with zebra mussels. (NS 2022) No observations have been recorded of this species either in Clinton Lake or the surrounding water bodies around the site.

3.7.8.3 <u>Species Protected Under the Bald and Golden Eagle Protection Act</u>

Bald eagles are protected under the BGEPA. The BGEPA was enacted in 1940 (16 USC 668-668c) and prohibits anyone without a permit issued by the Secretary of the Interior from "taking" bald eagles, including their parts, nests, eggs, or feathers. The BGEPA provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export, or import, at any time or any manner, any bald eagle … [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The BGEPA defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." (USFWS 2021)

"Disturb" means: "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle; 2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." In addition to immediate impacts, this definition also covers impacts resulting from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death, or nest abandonment. (USFWS 2021)

Bald eagles have been observed in the vicinity of the CPS site, as documented in a 2020 survey conducted on local birds around Clinton Lake. However, no eagles or eagle nests have been observed at the CPS operating station itself.

3.7.8.4 Species Protected Under the Migratory Bird Treaty Act

In addition to species protected under federal and state endangered species acts, there are numerous bird species protected under the MBTA that may visit CPS. The MBTA makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter or offer for sale, or purchase or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to federal regulations.

According to the USFWS, the following birds of conservation concern have the potential to occur in DeWitt County, Illinois: American golden-plover (Pluvialis dominica), bald eagle, black-billed cuckoo (*Coccyzus erythropthalmus*), bobolink (*Dolichonyx oryzivorus*), cerulean warbler (*Dendroica cerulea*), chimney swift (*Chaetura pelagica*), Henslow's sparrow (*Ammodramus henslowii*), Hudsonian godwit (*Limosa haemastica*), Kentucky warbler (*Oporornis formosus*), lesser yellowlegs (*Tringa flavipes*), prothonotary warbler (*Protonotaria citrea*), red-headed woodpecker (*Melanerpes erythrocephalus*), ruddy turnstone (*Arenaria interpres morinella*), rusty blackbird (*Euphagus carolinus*), short-billed dowitcher (*Limnodromus griseus*), upland sandpiper (*Bartramia longicauda*) and wood thrush (*Hylocichla mustelina*) (USFWS 2022a).

Suitable habitat is potentially present on the CPS site and in the vicinity for all of the species listed above. The American golden-plover, Hudsonian godwit, lesser yellowlegs, ruddy turnstone, rusty blackbird, and short-billed dowitcher occur as migrants through DeWitt County and may utilize stop-over habitat available onsite and in the vicinity. The black billed-cuckoo, bobolink, cerulean warbler, chimney swift, Heslow's sparrow, Kentucky warbler, prothonotary warbler, red-headed woodpecker, upland sandpiper, and wood thrush potentially breed in DeWitt County. (USFWS 2022a)

As described in Section 2.2.5.3 of this ER, CEG incorporates industry BMPs per guidance available through the Avian Power Line Interaction Committee, the USFWS, and benchmarking with fellow electric utilities in order to minimize personnel interactions, mortalities, and injuries to avian species at the site. An example of this is the installation of Agrilaser bird repellent systems at CPS in 2020.

3.7.8.5 Essential Fish Habitat

Essential fish habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act and refers to waters and substrate necessary for fish to spawn, breed, feed or grow to maturity. NOAA is responsible for identifying and describing EFH for sharks, tuna, and other highly migratory species that cross regional boundaries. NOAA only provides EFH for federally managed fish and invertebrates. (67 FR 2343)

A review of the NOAA EFH was conducted to determine the location of EFH within 6 miles of CPS. No EFH is located within the vicinity of CPS, nor were any EFH areas protected from fishing. As habitat areas of particular concern (HAPC) are derived from EFH, there were also no HAPCs located within the 6-mile vicinity of CPS. (NOAA 2022b)

Table 3.7-1 Primary Producers and Zooplankton in the Vicinity of the CPS Site

Common Name	Scientific Name
Periphyton [a]	
	Schizothrix calcicola
	Cladophora sp.[b]
	Stephanodiscus sp. [b]
	Navicula sp. [b]
Phytoplankton [a]	
	Melosira distans
	Actinastrum hantzschii
	Schizothrix calcicola
Zooplankton	
	Brachionus [b]
	Keratella [b]
	Polyartha [b]
	Synchaeta [b]
Order Cyclopoida	unknown
Order Calanoida	unknown
Order Cladocera	unknown

a. No common name for these species
b. Identified to genus

Table 3.7-2 Benthic Invertebrates in Clinton Lake in the Vicinity of the CPS site

Common Name	Scientific Name
Aquatic Worms	
Family Naididae (Tubificidae)	
Insects	
	Chaoborus punctipennis [(a)]
	Tanypus stellatus [(a)]
Genus *Procladius (holotanypus)*	
Mussels	
Plain pocketbook	*Lampsilis cardium*
White heelsplitter	*Lasmigona omplanata*
Genus *Corbicula*	

a = Recreational sportfish

Table 3.7-3 Fish Species in Clinton Lake in the Vicinity of the CPS Site

Common Name	Scientific Name
Fish	
Bigmouth buffalo	*Ictiobus cyprinellus*
Black bullhead	*Ameiurus melas*
Black crappie[(a)]	*Pomoxis nigromaculatus*
Blacknose crappie[(a)]	*Pomoxis nigromaculatus*
Blackstripe topminnow	*Fundulus notatus*
Bluegill	*Lepomis macrochirus*
Channel catfish[(a)]	*Ictalurus punctatus*
Common carp	*Cyprinus carpio*
Flathead catfish	*Pylodictis olivaris*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden redhorse	*Moxostoma erythrurum*
Golden shiner	*Notemigonus crysoleucas*
Green sunfish	*Lepomis cyanellus*
Largemouth bass[(a)]	*Micropterus salmoides*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Sebastes maliger*
Red shiner	*Cyprinella lutrensis*
River carpsucker	*Carpiodes carpio*
Shorthead redhorse	*Moxostoma macrolepidotum*
Smallmouth bass[(a)]	*Micropterus dolomieu*
Spotted sucker	*Minytrema melanops*
Walleye[(a)]	*Stizostedion vitreum*
White bass	*Morone chrysops*
White bass X Striped bass hybrid[(a)]	*Morone saxatilis* x *Morone chrysops*
White crappie[(a)]	*Pomoxis annularis*
Yellow bullhead	*Ameiurus natalis*

a = Recreational sportfish

Table 3.7-4 Terrestrial Species Likely to be Observed in DeWitt County, Illinois (Sheet 1 of 3)

Common Name	Scientific Name
Mammals	
Deer mouse	*Peromyscus maniculatus*
White-footed mouse	*Peromyscus leucopus*
Meadow vole	*Microtus pennsylvanicus*
Shorttail shrew	*Blarina brevicauda*
Least shrew	*Cryptotis parva*
White-tailed deer	*Odocoileus virginianus*
Eastern cottontail	*Sylvilagus floridanus*
American beaver	*Castor canadensis*
Coyote	*Canis latrans*
American red fox	*Vulpes fulva*
Grey fox	*Urocyon cinereoargenteus*
Muskrat	*Ondatra zibethicus*
Virginia opossum	*Didelphis virginiana*
Common raccoon	*Procyon lotor*
Striped skunk	*Mephitis mephitis*
American mink	*Mustela vison*
thirteen-lined ground squirrel	*Citellus tridecemlineatus*
Birds	
Red-winged blackbird	*Agelaius phoeniceus*
Common grackle	*Quiscalus quiscula*
Northern cardinal	*Cardinalis cardinalis*
Redheaded woodpecker	*Melanerpes erythrocephalus*
Dark-eyed junco	*Junco hyemalis*
Black-capped chickadee	*Poecile atricapilla*
Blue jay	*Cyanocitta cristata*
Mourning dove	*Zenaida macroura*
Northern flicker	*Colaptes auratus*
Downy woodpecker	*Picoides pubescens*
American crow	*Corvus brachyrhynchos*
Starling	*Sturnus vulgaris*
Ring-necked pheasant	*Phasianus colchicus*
Northern bobwhite	*Colinus virginianus*
Wild turkey	*Meleagris gallopavo*

Table 3.7-4 Terrestrial Species Likely to be Observed in DeWitt County, Illinois (Sheet 2 of 3)

Common Name	Scientific Name
Gyrfalcon	*Falco rusticolus*
Prairie falcon	*Falco mexicanus*
American widgeon	*Anas americana*
American black duck	*Anas rubripes*
Blue-winged teal	*Anas discors*
Coot	*Fulica americana*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Redhead	*Aythya americana*
Wood duck	*Aix sponsa*
Canada goose	*Branta canadensis*
Reptiles	
Snapping turtle	*Chelydra serpentina*
Painted turtle	*Chrysemys picta*
Spiny softshell turtle	*Apalone spinifera*
Kirtland's snake	*Clonophis kirtlandii*
Eastern racer	*Coluber constrictor*
Fox snake	*Elaphe vulpine*
Prairie kingsnake	*Lampropeltis calligaster*
Milk snake	*Lampropeltis Triangulum*
Northern water snake	*Nerodia sipedon*
Smooth greensnake	*Opheodrys vernalis*
Bull snake	*Pituophis melanoleucus*
Brown snake	*Storeria dekayi*
Plains garter snake	*Thamnophis radix*
Common garter snake	*Thamnophis sirtalis*
Eastern Massasauga rattlesnake	*Sistrurus catenatus*

Table 3.7-4 Terrestrial Species Likely to be Observed in DeWitt County, Illinois (Sheet 3 of 3)

Common Name	Scientific Name
Amphibians	
American toad	*Bufo americanus*
Fowler's toad	*Bufo fowleri*
Cricket frog	*Acris crepitans*
Western Chorus frog	*Pseudacris triseriata*
Plains Leopard frog	*Rana blairi*
Bullfrog	*Rana catesbeiana*

(EGC 2006; INHS 2022)

Table 3.7-5 Threatened or Endangered Species Occurring Near CPS or Within DeWitt County, Illinois

Common Name	Scientific Name	Legal Status
Plants		
Eastern prairie fringed orchid	*Platanthera leucophaea*	FT
Mussels		
Spike	*Elliptio dilatatus*	SE
Monkeyface	*Theliderma metanevra*	ST
Insects		
Rusty patched bumble bee	*Bombus affinis*	FE/SE
Monarch butterfly	*Danaus plexippus*	FC
Fish		
American brook lamprey	*Lampetra appendix*	ST
Reptiles		
Kirtland's snake	*Clonophis kirtlandii*	ST
Eastern Massasauga	*Sistrurus catenatus*	FT
Birds		
Northern harrier	*Circus cyaneus*	SE
Mammals		
Indiana bat	*Myotis sodalis*	FE
Northern long-eared bat	*Myotis septentrionalis*	FT

FE = federally endangered; FT = federally threatened; SE = state endangered; ST = state threatened; FC = federal candidate species
(IDNR 2022d; USFWS 2022a)

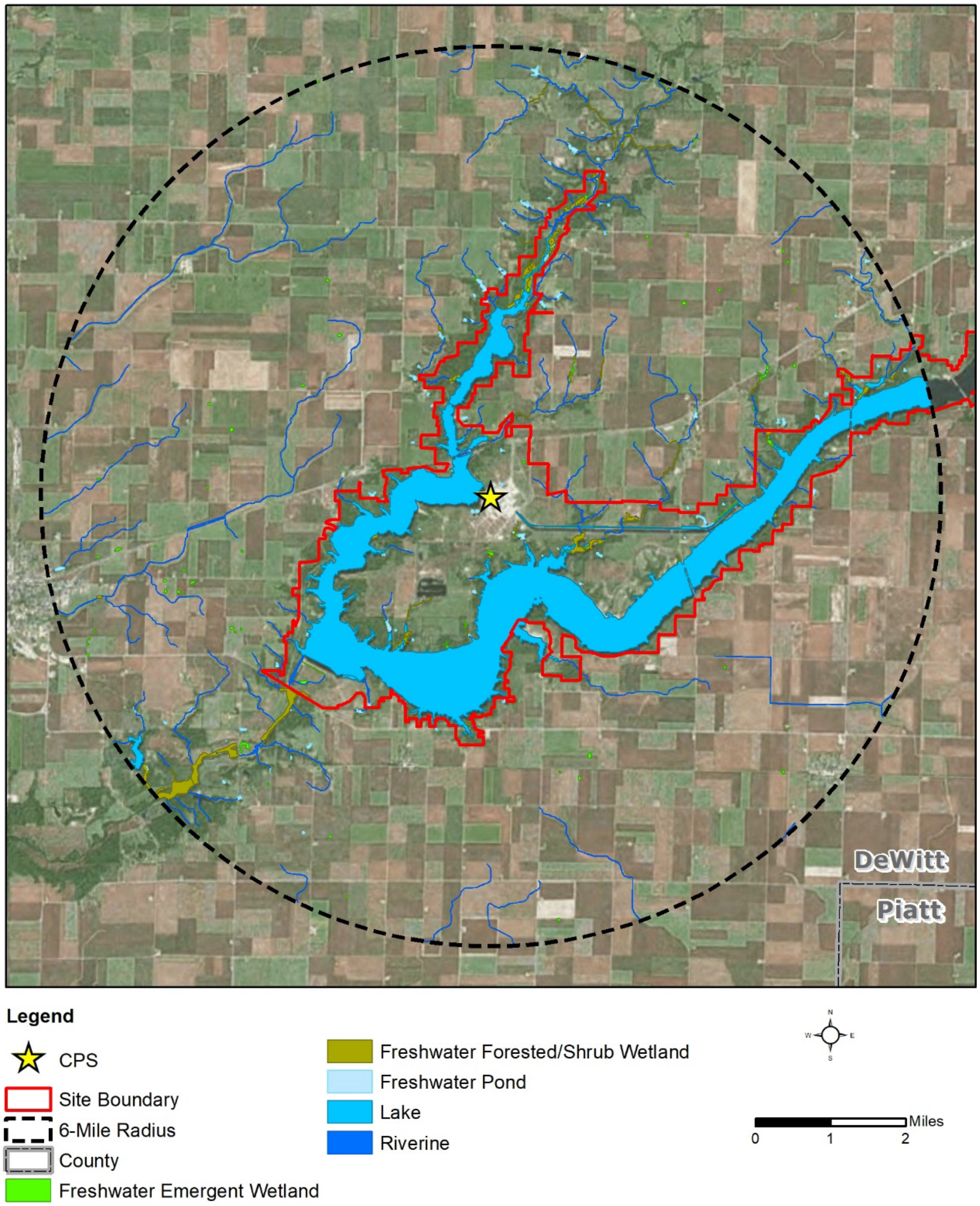


Figure 3.7-1 NWI Mapped Wetlands Within a 6-Mile Radius of the CPS Site

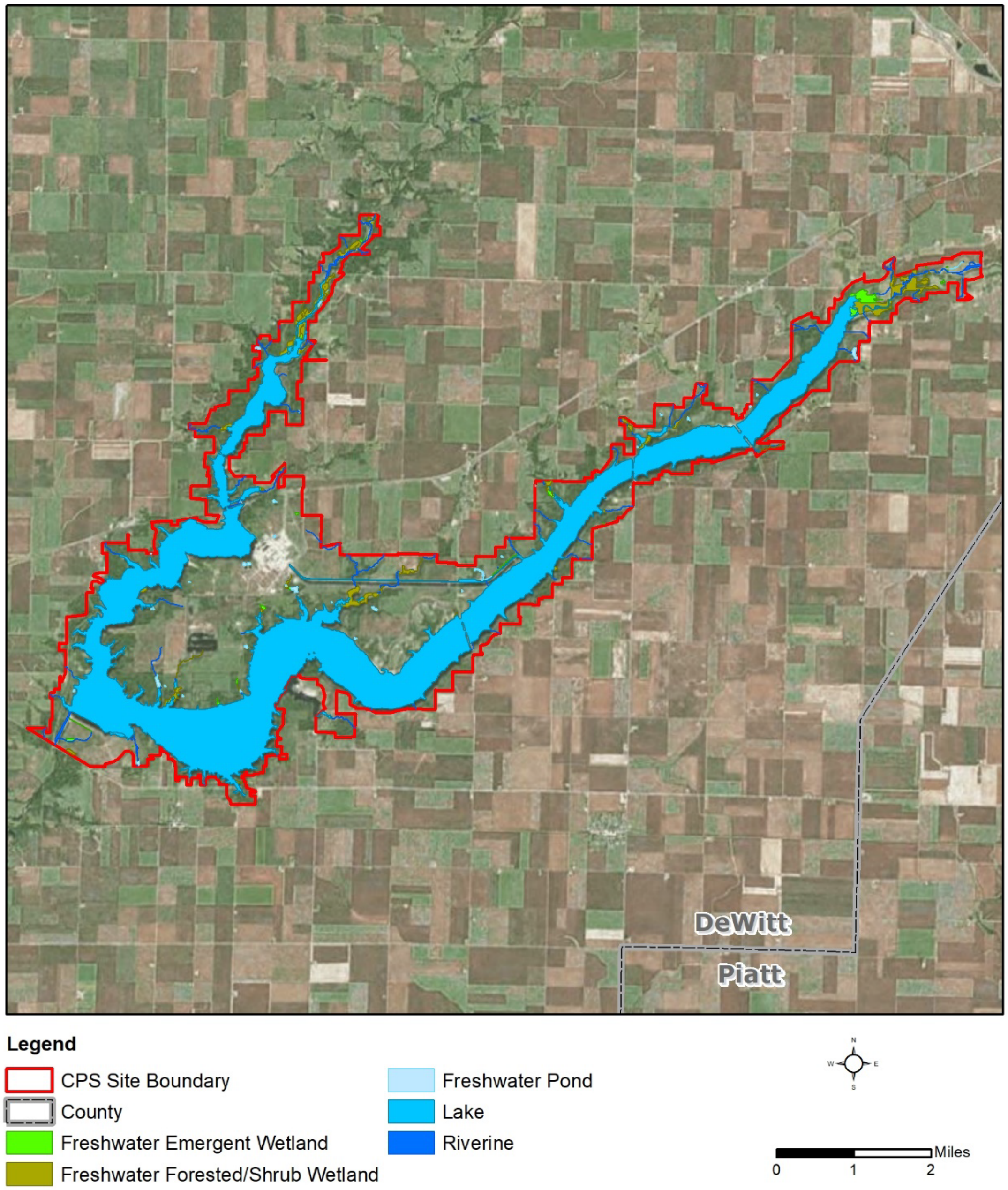


Figure 3.7-2 NWI Mapped Wetlands Within the CPS Site

3.8 Historic and Cultural Resources

Cultural resources include prehistoric era and historic era archaeological sites and objects, architectural properties and districts, and traditional cultural properties, which are defined as significant objects or places important to Native American tribes for maintaining their culture. (USDOI 1998) Of particular concern are those cultural resources that may be considered eligible for listing on the National Register of Historic Places (NRHP). Any cultural resources listed on or eligible for the NRHP are considered historic properties under the National Historic Preservation Act of 1966 (NHPA) [Public Law 89-675].

Prior to taking any action to implement an undertaking, Section 106 of the NHPA requires the NRC as a federal agency to do the following:

- Take into account the effects of an undertaking (including issuance of a license) on historic properties, including any district, site, building, structure, or object included in or eligible for inclusion in the NRHP.
- Afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertaking.

To provide early coordination for the Section 106 process, CEG contacted the Illinois Department of Natural Resources Historic Preservation Division concerning the CPS LRA and potential effects on cultural resources within the approximately 13,626-acre CPS site and on historic properties within a 6-mile radius of CPS. Native American groups recognized as potential stakeholders were also consulted by CEG with the opportunity for comment. CEG correspondence with the state historic preservation officer (SHPO) and consulting parties is included in Attachment D.

This ER identifies all known archaeological sites within the CPS property boundary, and within a 6-mile radius of CPS Unit 1, as well as properties listed on the NRHP within that same radius. The approximately 13,626-acre CPS property is described in Section 3.2. For the purpose of the LRA, the aboveground area of potential effect (APE) is defined as the entire CPS property and everything within a 6-mile radius of CPS Unit 1. The aboveground APE considers the visual integrity of historical properties in relation to continued CPS operation. The archaeological APE is also considered bounded by the approximately 13,626-acre property.

The LRA consists of an administrative action relative to historic and cultural resources. Although construction of the existing CPS facilities would have impacted any archaeological resources that may have been located within their respective footprints, much of the surrounding area remains largely undisturbed. There have been 17 documented previous cultural resources surveys, salvage, or testing investigations within the CPS property and extending out from the property (Table 3.8-1).

The literature review of previously recorded cultural sites included the area within a 6-mile radius of CPS. A records review was conducted at the Illinois State Archaeological Survey's

Illinois Cultural Resource Management Report Archive, the Illinois Inventory of Archaeological Sites (IIAS) restricted sites data base, and the Illinois Historic Preservation Divisions (IHPD) Historic and Architectural Geographic Information System (HARGIS). The purpose of the literature review was to help develop an understanding of the local context by conducting an inventory of all previously and newly recorded archaeological sites on the CPS property and within a 6-mile radius of CPS, regardless of NRHP status. The CPS site is depicted on Figure 3.1-1.

The results of the literature review showed that there are 230 cultural resources previously recorded within 6 miles of CPS. Of these 230 cultural resources, 14 are cemeteries protected by the Illinois Human Skeletal Remains Preservation Act (HSRPA), and no resources are NRHP listed. There are 202 archaeological sites, including one mid-nineteenth century cemetery and one prehistoric mound site that are protected by HSRPA. One archaeological site has been determined eligible for the NRHP, 135 archaeological sites are listed unassessed, 15 archaeological sites have been recommended for Phase II testing, and 49 sites are not eligible for the NRHP. The remaining 15 cultural resources are listings in the HARGIS inventory of structures and objects. All 15 of the HARGIS listings have an undetermined status (Tables 3.8-2, 3.8-3, and 3.8-4).

3.8.1 Land Use History

The land use history for CPS and the surrounding region was developed as part of a Phase 2A literature review and archaeological sensitivity assessment of the CPS property and is summarized here. Section 3.8.2 provides a more detailed discussion of historical land use as part of the cultural history. Early maps provide information on how the area was used in the past. The 1855 map shows the region served by the Illinois Central Railroad passing through Clinton, Illinois. Several roads connect Clinton with other regionally important cities and towns (Figure 3.8-1). (ILDC 2022) The composite USGS 1943 Monticello, Illinois; 1952 Arrowsmith, Illinois; 1951 LeRoy Illinois; and 1957 Maroa, Illinois, quadrangle 1:62,500 topo maps show the project APE prior to the impoundment of Clinton Lake. State Highway 54 is depicted passing through the dissected upland plain in the vicinity of the station, connecting Clinton with the communities of DeWitt and Farmer City (Figure 3.8-2). The composite Figure 3.8-3 USGS map depicts the 15 non-address restricted recorded cemeteries within the 6-mile radius of Unit 1 and the 13,626-acre CPS site boundary. The CPS site and Clinton Lake are depicted on Figure 3.8-3 along with the modern infrastructure in the vicinity after the construction of CPS.

Photographs taken prior to, during, and after the construction of the CPS facility are useful in showing the environmental context during that time period. As the earlier USGS maps discussed above, at the time of construction the CPS facility and reservoir area consisted of undeveloped prairie, riparian forest, and agricultural fields. At the construction site the trees and brush were removed, and the area was mechanically leveled and contoured to meet specific construction needs (Figure 3.8-5 and 3.8-6). Construction included excavation for the CPS facility components (Figure 3.8-5, 3.8-6, 3.8-7, and 3.8-8). Construction of the CPS facility included multiple buildings, structures, and parking lots (Figures 3.8-9 and 3.8-10). A general view of the CPS facility in 1993 is presented in Figure 3.8-11.

The CPS property and the surrounding region hold evidence of both prehistoric and historic occupation by Native Americans and Euro-Americans. Archaeological records suggest that the CPS property and the surrounding area were potentially occupied by Native American populations during the Paleoindian Period (prior to 8,000 BC) the Archaic Period (ca. 8,000 to 500 BC), the Woodland Period (ca. 500 BC to AD 900), Mississippian Period (ca. AD 900 to 1500), Late Prehistoric Period (AD 1400 to 1650), and the Historic Period (ca. AD 1650 to present). (IHPD 2022a)

3.8.2 Cultural History

3.8.2.1 Paleoindian Period (10,000 to 8,000 BC)

The Paleoindian period is the earliest substantiated cultural adaptation in the Americas and Illinois (ISM 2022). Paleoindian peoples have been defined as nomadic big game hunters who lived in small bands which traveled seasonally within set territories for food sources that included hunting megafauna. However, this definition is not adequate in light of the observed material culture and the lack of direct evidence of subsistence practices observed in the material culture at many Paleoindian sites. Less than 400 Paleoindian sites have been found in Illinois. Most Paleoindian sites in Illinois represent small temporary camps with a small number of artifacts. In contrast, the Lincoln Hills Site in Jersey County, Illinois, is a rare Paleoindian site where evidence of repeated site visits indicate that Paleoindian populated repeatedly visited the vicinity in order to take advantage of the readily available lithic resources. (ISM 2022) The prominent game species which would have been available in the region at the time would have included caribou and possibly mammoth or mastodon. The Kimmswick site south of St. Louis, Missouri, was investigated by the Illinois State Museum in 1979 and provides a correlate to the types of game available to the region's Paleoindian populations. A Clovis point was found in contact with mastodon leg bone, and a giant sloth hide represent some of the subsistence base and faunal remains utilized by these ancient populations of Illinois and the regional area. The Paleoindian tool kit and possibly their very nomadic hunting and lifeways transitioned from Paleoindian to the Archaic Period coinciding with the end of the Ice Age by 10,000 years ago. (ISM 2022)

3.8.2.2 Archaic (8,000 to 500 BC)

The Archaic Period is marked by changes in subsistence and settlement patterns likely associated with changes in climate and resulting environmental change. The long duration of the Archaic Period includes episodes that were warmer and drier, as well as cooler with greater precipitation. These fluctuations mark rapid and significant change in the climate and ecology of the region. (ISM 2022) This period is divided into the Early, Middle, and Late Archaic and is characterized by the exploitation of a larger variety of plant and animal resources with an overall greater diversity in material culture.

The transition to the Early Archaic Period occurred approximately 10,000 years ago and is inferred to include a less mobile and more localized lifestyle than the preceding Paleoindian Period. At this time the warmer and drier conditions of the Early Archaic led to an increase of the prairie ecotone and a general decrease of the forest vegetation on the flatlands in the central portion of modern Illinois. The Early Archaic populations of the region not only adapted their subsistence practices to the regions changing large game and smaller animal populations, but they also domesticated the wolf into the domestic dog. When or how this relationship with *Canis familiaris* took place is unknown, but some of the earliest dog burials in North America have been found at the Koster site in Green County, Illinois, where archaeologists found four dog burials in shallow graves similar to the Early Archaic burials for human adults and children. Charcoal in one of the dog burials yielded a date of 8,500 years ago. (ISM 2022) Projectile points no longer exemplified the intricate work characteristic of Paleoindian tools. Early Archaic tools such as spear points, large knives, drills, scrapers, and gravers were still used, but varied in size and shape and were often stemmed. (DIA 2009) The variety of stylized stemmed bifaces may indicate a greater regional separation among Early Archaic populations. The use of local cherts for tool manufacture may also be an indicator of the population's greater familiarity with local resources. Subsistence remains a generalized foraging strategy concentrating on deer, smaller mammals, the nut mast and roots and tubers. (DIA 2009)

Between 8,000 to 5,000 years ago, Illinois changes began to occur in the location of sites across the landscape. The drier Hypsithermal Interval brought an increase in the prairies due to both warmer and drier conditions than the present. As a result, population increased in the major river valleys, as the uplands may have not offered the same resource base as in previous climatic conditions. The Middle Archaic population made use of base camps at the floodplain edge. From these base locations, the groups could take advantage of many different resources without the need to change the location of the settlement. These locations allowed the population to take advantage of the riverine and aquatic resources. There are indications of regional territories and a corresponding intensive knowledge and utilization of the natural resource base. There is an increase in the number of sites, the density of material remains, and a greater diversity of the types of sites, which are all indicative characteristics of an increasing population with ever reduced mobility but continue to take advantage seasonal regional natural resources. Groundstone tools were added to the toolkit to process plant foods such as nuts, seeds, and tubers. Distinctive grooved axes and other woodworking tools, such as adzes were added to this Middle Archaic toolkit, and were probably utilized to construct dugout canoes, and wood framed dwellings. Another marker of the Middle Archaic, the atlatl, is indicated by the bannerstone weights utilized on these spear throwing devices. (DIA 2009).

During the Late Archaic Period, 5,000 and 2,500 years ago, villages with increased population continue to settle in areas near a variety of subsistence resources, often in the major river valleys. The Late Archaic populations settled into these environs, and rapid population density increase is indicated by a dramatic increase in stone grinding implements, projectile points, knives, drills, scrapers, and flake tools. The increase in the numbers and presence of bone fishhooks, harpoon heads and stone net weights indicates an increasing utilization of riverine aquatic resources as well. One author notes that the Late Archaic sites reveal the first unambiguous evidence of regionally specific seasonal territoriality, limited gardening of squash and several native plant seeds, and long-distance trade based on both raw materials and finished artifacts made from nonlocal materials. These exotic goods were often found in single graves and are inferred to be markers of status. (DIA 2009)

3.8.2.3 Woodland (500 BC to 900 AD)

The Early Woodland Period in Illinois correlates with the technological innovation of the first pottery in the region. The Early Woodland sites of 600 to 200 BC are typically temporary, small, and often located on floodplains. There is little evidence of the previous burial and mortuary activities that marked the previous terminal Archaic Prairie Lake culture of substantial villages with cemeteries. (DIA 2009) In time, the Havana Hopewell Culture developed rapidly in the central Illinois River Valley by 200 to 150 BC, which was followed by mound building and the participation in the Hopewellian mortuary rituals between 100 BC to AD 1. (DIA 2009) An increase in the frequency of charred seed such as knotweed, goosefoot, marsh elder, and sunflowers suggest incipient agriculture. Other plants such as squash, gourds, barley, and tobacco are also present and indicate the beginnings of village horticulture. Earthen mounds sites are the most common and visual remains of this activity. Known mounds are most often located on high bluffs or on terraces overlooking major waterways. (DIA 2009) The interactions of the central Illinois populations with the Ohio Hopewell centers may not have been as frequent as previous scholars have thought. As the raw materials for many of the elaborately decorated vessels, pipestone effigy pipes, and other Ohio Hopewell correlates may have been available in Illinois and appear to be of local manufacture. Nevertheless, the communication between the local populations and the stylistic influences of the Ohio Hopewell are indicated. Such sharing of ideas and ritual served to solidify regional trade, relationships, and the exchange in all types of raw materials and subsistence items during the Middle Woodland. (DIA 2009) The Hopewellian systems of trade and ritual of the Middle Woodland disappear from the archaeological record in Illinois by AD 350-450.

The Late Woodland (AD 500-900) period is characterized by a mild climate, and archaeological sites from the period are numerous throughout Illinois. The pottery of the era shows less regional specialization and are fewer variations in the styles. The villages grow, which is an indication of social complexity. The population increases with the growing dependence on maize agriculture. The lifespan of the maize-dependent populations decreases, and the introduction of the bow and arrow increases the hunting efficiency of the region's game. The bow and arrow were also becoming an efficient weapon to defend territory and resolve disputes from a distance. (DIA 2009) The region's increasing population density led to the rapid development of regional cultural traditions. Late Woodland populations were forced to make a choice between defending regional boundaries or acceptance of dissimilar cultures in near proximity. By the turn of the first millennium, the choice to ignore those nearby would no longer be an option. (DIA 2009)

3.8.2.4 Mississippian Period (900 AD to 1500)

The native populations of southwest Illinois in the American Bottom began to aggregate into semi-permanent settlements in the Late Woodland. As the populations became more sedentary, the development of their maize agricultural system also advanced, and they became dependent upon it for subsistence. As the population increased, the social and political complexity increased. The towns were moving from a tribal pattern of informal kin-dominated relationships to a more formal organization. By AD 1050, the American Bottom society had transformed from village locations to one of several temple mound plaza centers with multiple neighborhood clusters of houses surrounding the plaza. (DIA 2009) All aspects of culture seem to have been affected by the shift in location. Traditional, or cultural variations in ceramics gave way to a singular shell tempered ceramic style among the previously diverse multitudes of the inhabitants of the plaza centers. Even the previous central post house style changed to wall trench construction. (DIA 2009) While Cahokia may have been the largest and most influential of the Mississippian centers in Illinois, other populations persisted in Illinois along the Spoon and Central Illinois Valleys. Additionally, there is evidence that some of the Late Woodland populations remained in many areas, and Mississippians moved to these "rural" areas and perhaps influence the northern populations towards community patterning. The result was that the more northern Mississippians led a less stratified and egalitarian life than those in the American Bottom. Additionally, there were distinct Mississippians in Ohio and Kentucky which also vied for trade and regional power. Overall, the fortified nature of the larger Mississippian settlements gives insight into the conflict throughout the region, as does the violence ridden remains of many from this period. (DIA 2009) Storage pits, distinctively decorated pottery, triangular arrow points, maize, beans, and squash are all indicative of the fully agricultural Mississippian culture. While bones from birds, mammals and fish are indicative that traditional wild foods continued in importance after the adaption of maize agriculture. One noted trait of Upper Mississippians was the long houses occupied by a number of families. (DIA 2009)

While the Mississippian culture was widespread in Illinois, it was not the only culture moving though portions of Illinois at the time. The Oneota, as well as Langford tradition populations, were present in Northern Illinois after AD 1200, with the Oneota occupying northeastern Illinois and western Indiana. While the Lanford tradition population concentrated in northwestern Illinois and Iowa. (DIA 2009) The Oneota tradition populations resided in less aggregate populations in small villages. While there were many factors in the demise of the Mississippian culture in Illinois, such as climatic change to a cooler period, which made the maize-adapted economy less productive and inefficient to support the aggregated population. Conflict and warfare undoubtably played a role in the ever-decreasing population as well. The groups that occupied Illinois after the Mississippian period are not well known, nor was the population very large. It is noted that by AD 1500 and 1600 only a few places in Illinois appear to have been occupied, and that few sites with dates past AD 1400 have been recorded in the state. (DIA 2009)

3.8.2.5 Historic Period (1650 AD to Present)

The Colonial Period begins in the 1673 when French explorers arrive from Canada in their attempt to determine if the Mississippi River indeed flowed south to the Gulf of Mexico. Fur trader Louis Jolliet, accompanied by Jesuit priest Jacques Marquette and five boatmen in two canoes, descended the Mississippi River to the Arkansas River before returning to the Great Lakes. They encountered two villages of Illinois Nation, the Peoria, and the Kaskaskia. By the late 1600s the Illinois controlled most of southern, central, and western Illinois, while the Miami occupied several villages in northern Illinois. (DIA 2009) Throughout the 1600s and 1700s, Illinois was occupied by a variety of Native Americans. As the population of the Illinois Nation diminished in the 1700s and the Miami moved into modern Indiana, the void was filled by the Mesquakie, Iowa, Kickapoo, Mascouten, Piankashaw, Potawatomi, and Sauk, who occupied much of the former Illinois Nation lands. The Ho-Chunk arrived in the early 1800s. By 1832, treaties and land cessions with the US Government led to virtually all of these groups being removed from Illinois. (DIA 2009) The American Period in Illinois essentially begins with George Rogers Clark capturing the British held town of Kaskaskia and securing Illinois for Virginia in 1878. (DIA 2009; IHPD 2022a) By the early 1818, it is estimated that up to 35,000 Americans lived in Illinois, primarily in the southern areas in the wooded bottom lands where they could practice subsistence farming in the fertile, easily tilled soils. After 1832 when the Native Populations were removed west, the population of Illinois increased dramatically. Most of these early settlers were from the southern states, including the Carolinas and Tennessee. The second migration after Native American removal was primarily of northern Americans. These two different cultural groups of Americans are evident by the different styles of house, barns, and eighteenth-century archaeological sites that these dichotomous populations left on the landscape. (DIA 2009)

Numerous transportation projects of the mid-nineteenth century changed the economy and culture of Illinois. The railroads and canals created shipping options for farmers, merchants, industrialists, and manufacturers of interior Illinois. By 1850, Illinois was the fourth largest state in the Union. Additionally, the invention of the steel plow by John Deere in 1837 allowed the breaking of the prairie which led to greater farming which opened up substantially more fertile cropland. (DIA 2009; IHPD 2022a) The opening of the Illinois Central Railroad transformed Illinois as a major commercial center.

The latter half of the nineteenth century continued to bring new industry to DeWitt County and the Clinton vicinity. Agriculture has always been a predominant industry in the region. Today agriculture is still a major part of the economy of central Illinois and DeWitt County. The Clinton Power Station Unit 1 construction began in 1976, went online April 17, 1987, and added substantial economic impact to the county. The property taxes from the power station created substantial benefit to the regional schools.

3.8.3 Onsite Cultural Resources

Onsite cultural resources are those located within the 13,626-acre site of the CPS property. That property includes the entirety of the archaeological APE, which is also the onsite portion of the aboveground APE. A review of the IIAS online database revealed that there are 172 archaeological entries and three cemeteries listed within the 13,626-acre CPS site. None of the 175 onsite cultural resources are listed on the NRHP. One cultural resource, 11DW15, also known as the Pabst site, has been determined eligible for the NRHP. Additional salvage investigations at the Pabst Site were conducted in the mid-1970s to gain a greater understanding of the Archaic Period in central Illinois from the 1 meter (3.3 feet) thick deposits in the 2-hectare (5-acre) site. The IIAS lists the Pabst site status as "DOEd Phase III complete." The IIAS lists 118 archaeological sites as unassessed, 13 archaeological sites are listed for Phase II testing, 40 sites are listed not eligible/determined not eligible after Phase II testing, and the three cemeteries are protected by the HSRPA laws for human remains (Table 3.8-2). No structures within the CPS property have been documented through the Historic American Buildings Survey or Historic American Engineering Record programs.

3.8.4 Offsite Cultural Resources

Offsite cultural resources are those outside the 13,626-acre CPS property boundary. There are 55 offsite cultural resources within 6 miles of the CPS. Lists of the known cemeteries, archaeological sites, and historic structures and objects within a 6-mile radius of CPS are presented in Tables 3.8-2, 3.8-3 and 3.8-4. The IIAS lists 30 archaeological sites and 10 cemeteries within 6 miles of the CPS site. The HARGIS system lists 15 architectural structures and objects within 6 miles of CPS. (IHPD 2022b) There are no NRHP or SHPO DOE listed cultural resources listed within 6 miles of CPS. The 10 cemeteries are protected by the Illinois HSRPA law. The 30 archaeological sites include 9 sites that are not eligible for the NRHP, 16 sites that are unassessed, 2 sites that have been recommended for Phase II testing, and 1 mid-nineteenth century cemetery, which is protected by the Illinois HSRPA law. The 15 architectural structures and objects all have an undetermined status for the NRHP. The locations of the 15 architectural structures and objects are listed in Table 3.8-4. The unrestricted locations of 13 cemeteries within 6 miles of CPS are presented on Figure 3.8-3.

3.8.5 Cultural Resource Surveys

There have been 17 previous cultural resources surveys and salvage and testing investigations within the 13,626-acre CPS site. Prior to the construction of CPS and the impoundment of Clinton Lake, a cultural resources survey (IIAS Survey #755) of the CPS site was conducted under the auspices of the Illinois State Museum. The cultural resources survey investigation consisted of a survey of approximately 17,000 acres in the vicinity of the proposed CPS site in the summer of 1973 and resulted in the recording of 132 sites in the proposed Clinton Reservoir. Ten of the sites recorded during the survey that had temporally diagnostic materials, such as projectile points, were recommended for further investigations. The Illinois State

Museum tested the 10 sites in 1974 (IIAS Survey #794). In 1975, the Illinois State Museum continued investigations at the Pabst Site (IIAS Survey #754).

Due to the location of the site near the proposed water intake structure of the proposed station, these investigations were more a salvage operation than the testing activities conducted the previous season. The Pabst site was an area of repeated occupation during the Archaic Period beginning 4,000 years ago. The site appears to have been a base camp from which small task groups departed to hunt and gather resources to bring back to use at the camp. (NRC 2006) It is reported that Lewis prepared an application for nominating the Pabst Site to the NRHP; however, the site is not on the NRHP nor listed as removed in 2022. Instead, as mentioned above, the site is listed on the IIAS data base as "DOEd Phase III complete." The Illinois State Museum investigated areas within the CPS site for recreation facilities twice in the mid-1980s. The survey (IIAS Survey #1883) for the electric utility line at Camp Quest Group Campground resulted in the recording subsequent testing of site 11DW286 (IIAS Survey #13397). The site was determined not eligible after Phase II testing.

The other study (IIAS Survey #2287) included field work in the Clinton Lake Recreation Area in 1985 but did not result in the recording of any cultural resources at that location within the CPS site. Five additional surveys in 1989 (IIAS Survey #3151; IIAS Survey #3230; IIAS Survey #3275; IIAS Survey #3295; IIAS Survey #3296) and 1990 at the Clinton Lake State Recreation Area within the CPS site did not result in the recording of any new cultural resources. Additional survey and testing work was carried out by the Illinois State Museum for dredging operation (IIAS Survey #4000) and dredge disposal (IIAS Survey #4001) that resulted in the recording of 27 sites and 12 isolated finds. Seven of the sites were recommended for further testing, resulting in 2.64 hectares (6.52 acres) of land being disced and examined further for cultural material. No further work was recommended for any of seven archaeological sites which were examined and none of the 26 sites are eligible for the NRHP.

In the spring of 1990, the Illinois State Museum conducted a survey for fire lanes and other activities at the Clinton Lake State Recreation Area (IIAS Survey #3789) within the CPS site. The survey resulted in the recording of 11 archeological sites, 11DW334 to 11DW344, which were all recommended not eligible for the NRHP. In the fall of 1994, the Illinois State Museum conducted fieldwork (IIAS Survey #5646) for recreational facility improvements at the Clinton Lake State Recreation Area inside the CPS site. The survey resulted in the recording of site 11DW359, which was recommended not eligible for the NRHP. The Illinois State Museum completed a survey (IIAS Survey #102523) in the spring of 2000 for a proposed wastewater treatment plant at the Clinton Power Station for Dynegy Midwest Generation. The survey resulted in the recording of site 11DW360, a late nineteenth to early twentieth century historic scatter, which was recommended not eligible for the NRHP. The Illinois State Museum conducted a survey (IIAS Survey #11797) in the spring of 1991 for an undefined Borrow project within the CPS site. The survey resulted in the recording of site 11DW145. The report states that the site would be avoided; however, the IIAS database indicates that the site is not eligible for the NRHP, and the project was cleared by the Illinois Historic Preservation Agency in 1991.

The Illinois State Museum conducted a survey (IIAS Survey #12481) for a wetland development project at the Clinton State Recreation Area within the CPS site in the spring of 2002. The survey did not result in the recording of any cultural resources. The Illinois State Museum conducted Phase II investigations (IIAS Survey #13397) of site 11DW286 within the Clinton Lake State Recreation area. The Phase II testing of the site resulted in the recovery of five blocky fragments, three unretouched flakes and a 22-caliber shell casing. The site was recommended not eligible for the NRHP. The Illinois State Museum conducted a survey (IIAS Survey # 17286) in the spring of 2006 for an alternate borrow area for a wetland development at the Clinton Lake State Recreation Area within the CPS site. The survey did not result in the recording of any cultural material. One final survey area is listed in the IIAS data base, Survey 99999; however, there is no organization, project, or date listed for the survey.

3.8.6 Procedures and Integrated Cultural Resources Management Plans

CPS has administrative procedures to protect previously unknown historic or cultural resources that may be discovered on the site. CPS has an Excavation, Trenching and Shoring procedure, which aims to identify, protect, and minimize the potential of impact to cultural resources within the CPS facility. The procedure states that activities governed by the Excavation, Trenching, and Shoring Procedure shall be planned and implemented by use of the Excavation Permit. The procedure also defines Archaeological, Cultural and Historical (AC&H) resources, and is designed to protect against the impacts to properties, sites and unanticipated discoveries of AC&H. The section on pre-job planning discusses the performance of a review of previous cultural studies for the potential presence of cultural material in the area to be excavated, and the need to conduct an archaeological survey in areas where previous cultural, historical or paleontological studies have not been conducted. Further, environmental personnel are to be contacted to arrange for appropriate studies or surveys to be conducted. The procedure outlines the steps to take if an excavation or other ground disturbance is planned in any area on the property. The procedures outline the stop work process and additional steps required if an unanticipated discovery of AC&H is encountered during any ground-disturbing activities.

Table 3.8-1 Previous Cultural Resources Surveys and Salvage Work Within the CPS Property (Sheet 1 of 3)

IIAS Survey ID	Survey Company or Organization and Author	Report Date	Description	Findings
754	Illinois State Museum R. Barry Lewis	1976	Archaeological Salvage Investigations at the Pabst Site, DeWitt County	Testing and salvage of prehistoric site 11DW15
755	Illinois State Museum Sheila Lewis	1973	An Archaeological Survey of the Proposed Clinton Reservoir, DeWitt County	132 sites
794	Illinois State Museum R. Barry Lewis	1975	Archaeological Salvage Investigations in the Proposed Clinton Reservoir, DeWitt County, Illinois	Testing and salvage work at 10 sites recorded during the 1973 survey
1883	Illinois State Museum Frances R. Knight and Julia E. Clifton	1987	Installation of Underground Electric Lines at the Camp Quest Group Campground at Clinton Lake State Recreation Area	One prehistoric site with a spent bullet, 11DW286, determined not eligible after Phase II testing (See entry 13397; 1990)
2287	Illinois State Museum Hassen et al.	1987	Cultural Resources Studies at Illinois Department of Conservation State Parks and Recreation Areas, Volume One: The 1985 Season	No sites found on the Clinton Lake Recreation Area portion of this group of studies
3151	Illinois State Museum Harold Hassen	1990	Construction of a Shower Facility at the Campground in the Mascoutin area of Clinton Lake State Recreation Area	No sites found
3230	Illinois State Museum Harold Hassen	1990	Enlargement and graveling of two existing Earthen Hunter Parking lots at Clinton Lake State Recreation Area	No sites found
3275	Illinois State Museum Harold Hassen	1989	Construction of a Fish Rearing Pond at Mascoutin Area at Clinton Lake	No sites found
3295	Illinois State Museum Harold Hassen	1989	Survey of a Proposed Borrow Area to be Used for Dam Restoration Along a Pond in the Uplands along Clinton Lake	No sites found

Table 3.8-1 Previous Cultural Resources Surveys and Salvage Work Within the CPS Property (Sheet 2 of 3)

IIAS Survey ID	Survey Company or Organization and Author	Report Date	Description	Findings
3296	Illinois State Museum Harold Hassen	1989	Sewage Holding Tanks at 3 Fish Cleaning Stations at Clinton Lake Will be Replaced with Sand Filter Sewage Treatment Systems	No sites found
3789	Illinois State Museum Harold Hassen	1991	Survey of a Level Field and Strips/Firelanes Cleared of Vegetation at Clinton Lake State Recreation Area	11 archaeological sites 11DW334 to 11DW344
4000	Illinois State Museum Steven R. Ahler	1990	Phase I Cultural Resources Assessment of Dredging Operations at the Clinton Power Station, IHPA number 90010505, Corps of Engineers Permit number CENCR-OD-S-18837Z	27 archaeological sites; 11DW287 to 11DW313, 12 isolated finds
4001	Illinois State Museum Steven R. Ahler	1990	Phase II Cultural Resource Evaluation of Dredge Disposal Facility at the Clinton Power Station, IHPA number 90010505 Corps of Engineers Permit number CENCR-OD-S-18837Z	Seven sites; 11DW287, 11DW290, 11, DW294, 11DW303, 11DW305, 11DW306, 11DW308
5646	Illinois State Museum Steve Stringer	1994	Peninsula Pt. Day Use Picnic Shelter and Grading, Clinton Lake State Recreation Area	One prehistoric site, 11DW359, recommended not eligible
10253	Illinois State Museum W. Gordan Howe	2000	Phase I Archaeological Survey for Proposed Construction at the Wastewater Treatment Plant, Clinton Power Station, DeWitt County, Illinois	One late 19th to early 20th century site, 11DW360, recommended not eligible
11797	Illinois State Museum Harold Hassen	1991	Borrow Area	One prehistoric site, 11DW145
12481	Illinois State Museum Christy S. Rickers	2002	Phase I Archaeological Survey for Proposed Shallow Water Wetland Development, Clinton Lake State Recreation Area, DeWitt County, Illinois	No sites found

Table 3.8-1 Previous Cultural Resources Surveys and Salvage Work Within the CPS Property (Sheet 3 of 3)

IIAS Survey ID	Survey Company or Organization and Author	Report Date	Description	Findings
13397	Illinois State Museum Frances R. Knight	1990	Archaeological Investigations at Selected Sites, Salt Creek Drainage Illinois: Clinton Lake State Recreation area, Weldon Springs State Recreation Area, and James Helfrich Game Farm	One prehistoric site with a spent bullet, 11DW286, determined not eligible after Phase II testing (See entry 1883; 1990)
17286	Illinois State Museum Jill L. Bickel and Dawn E. Cobb	2008* (Report dated 2006)	Phase I Archaeological Survey for Proposed Alternate Borrow Area for Wetland Development, Clinton Lake State Recreation Area, DeWitt County, Illinois	No sites found
99999	Unknown	NA	Survey area listed on Illinois Inventory of Archaeological Sites; no associated files	NA

*Illinois Cultural Resource Management Report Archive database report date

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 1 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
2451	Farmer City South	McCord Cemetery	Protected by HSRPA Burial Law
2508	DeWitt	Wilmore Cemetery	Protected by HSRPA Burial Law
2558	DeWitt	Lisemby Cemetery	Protected by HSRPA Burial Law
11DW6	DeWitt	Prehistoric battle site	Unassessed
11DW15	DeWitt	Late Archaic site	Phase III completed
11DW19	Farmer City South	Unassigned Prehistoric habitation site N=40+	Unassessed
11DW64	DeWitt	Early to Middle Archaic habitation site N=13	Unassessed
11DW65	Farmer City South	Unassigned prehistoric habitation site N=10	Unassessed
11DW97	DeWitt	Middle to Late Archaic habitation site N=5	Unassessed
11DW98	DeWitt	Early Archaic habitation site (base camp) N=37	Unassessed
11DW145	DeWitt	Unassigned prehistoric lithic scatter N=11	Not eligible
11DW147	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW148	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW149	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW150	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW151	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW152	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW153	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW154	DeWitt	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 2 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW155	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW156	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW157	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW158	DeWitt	Early Archaic lithic scatter	Unassessed
11DW159	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW160	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW161	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW162	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW163	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW164	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW165	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW166	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW167	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW168	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW169	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW170	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW171	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW172	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW173	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW174	Perry	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 3 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW175	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW176	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW177	DeWitt	Unassigned Archaic lithic scatter	Unassessed
11DW178	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW179	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW180	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW181	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW182	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW183	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW184	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW185	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW186	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW187	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW188	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW190	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW191	DeWitt	Late Woodland lithic scatter	Unassessed
11DW192	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW193	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW194	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW195	DeWitt	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 4 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW196	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW197	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW198	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW199	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW200	Clinton	Isolated find of an unassigned prehistoric lithic drill fragment	Unassessed
11DW201	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW202	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW203	DeWitt	Unassigned prehistoric lithic scatter (no cultural material listed)	Unassessed
11DW205	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW206	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW207	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW208	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW209	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW210	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW211	DeWitt	Late Archaic lithic scatter	Unassessed
11DW212	DeWitt	Early Archaic lithic scatter	Unassessed
11DW213	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW215	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW217	DeWitt	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 5 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW218	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW219	DeWitt	Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW220	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW221	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW222	DeWitt	Early Archaic and Late Woodland lithic scatter	Determined not eligible after Phase II testing
11DW223	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW224	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW225	DeWitt	Unassigned Woodland lithic scatter with shell fragments	Unassessed
11DW226	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW227	DeWitt	Unassigned lithic scatter with shell fragments	Unassessed
11DW228	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW229	DeWitt	Middle to Late Archaic lithic scatter	Recommended for Phase II Testing/Unassessed
11DW230	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW231	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW232	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW233	DeWitt	Early Archaic lithic scatter	Unassessed
11DW234	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW235	DeWitt	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW236	DeWitt	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 6 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW237	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW238	DeWitt	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW240	DeWitt	Unassigned Woodland lithic scatter	Determined not eligible after Phase II testing
11DW241	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW242	DeWitt	Middle to Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW243	DeWitt	Early Archaic and Middle Woodland lithic scatter	Determined not eligible after Phase II testing
11DW244	DeWitt	Unassigned Woodland lithic scatter with shell	Unassessed
11DW245	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW246	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW247	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW248	DeWitt	Middle to Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW249	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW250	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW251	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW252	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW253	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW254	DeWitt	Unassigned Archaic lithic scatter	Unassessed
11DW255	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW256	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW257	DeWitt	Unassigned prehistoric lithic scatter	Unassessed

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 7 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW258	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW259	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW260	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW261	Clinton	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW262	Clinton	Late Archaic camp	Determined not eligible after Phase II testing
11DW263	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW264	Clinton	Unassigned prehistoric village or camp	Unassessed
11DW265	Farmer City South	Late Archaic and Late Woodland habitation site	Phase II Not eligible
11DW266	Farmer City South	Middle to Late Woodland village or camp	Phase II Not eligible
11DW267	Farmer City South	Unidentified Archaic lithic scatter	Unassessed
11DW268	Farmer City South	Unidentified prehistoric lithic scatter	Unassessed
11DW270	Farmer City South	Unassigned prehistoric lithic scatter	Unassessed
11DW271	Farmer City South	Unidentified Archaic lithic scatter	Unassessed
11DW272	Farmer City South	Unassigned prehistoric lithic scatter	Unassessed
11DW273	Farmer City South	Unassigned prehistoric lithic scatter	Unassessed
11DW286	DeWitt	Unassigned prehistoric lithic scatter and a spent bullet N=18	Determined not eligible after Phase II testing
11DW287	DeWitt	Multicomponent site; Late Woodland to Mississippian habitation site, with a crockery sherd N=32	Determined not eligible after Phase II testing

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 8 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW288	DeWitt	Multicomponent site; unassigned prehistoric lithic flake with two whiteware fragments N=3	Not eligible
11DW289	DeWitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW290	DeWitt	Multicomponent site; unassigned prehistoric lithic scatter with two fragments of 20th century crockery N=38	Determined not eligible after Phase II testing
11DW291	DeWitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW292	DeWitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW293	DeWitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW294	DeWitt	Early Archaic lithic scatter N=20	Determined not eligible after Phase II testing
11DW295	DeWitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW296	DeWitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW297	DeWitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW298	DeWitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW299	DeWitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW300	DeWitt	Unassigned prehistoric lithic scatter	Not eligible
11DW301	DeWitt	Multicomponent site; prehistoric lithic scatter N=13. 1870s to 1920 debris scatter with a concrete foundation N=over 130	Not eligible
11DW302	DeWitt	Unassigned prehistoric lithic scatter N=8	Not eligible

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 9 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW303	DeWitt	Late Archaic habitation site N=14	Determined not eligible after Phase II testing
11DW304	DeWitt	Early to mid-20th century glass and ceramic scatter N=14, with brick, concrete, and glazed tile fragments	Not eligible
11DW305	DeWitt	Early Archaic and Late Woodland habitation and lithic scatter N=10	Determined not eligible after Phase II testing
11DW306	DeWitt	Middle Archaic lithic scatter N=3	Determined not eligible after Phase II testing
11DW307	DeWitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW308	DeWitt	Late Archaic lithic scatter N=5	Determined not eligible after Phase II testing
11DW309	DeWitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW310	DeWitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW311	DeWitt	Multicomponent site; prehistoric lithic scatter N=14, 1870s to 1920 glass and ceramic scatter with a brick and concrete fragments N=over 400	Determined not eligible after Phase II testing
11DW312	DeWitt	Unassigned prehistoric lithic scatter with one glazed brick/tile N=5	Not eligible
11DW313	DeWitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW334	Farmer City South	Multicomponent site; unassigned prehistoric scatter N=9; unassigned historic glass scatter N=2	Recommended for Phase II testing
11DW335	Farmer City South	Multicomponent site; Paleoindian to Early Archaic artifact scatter N=41; mid-19th to mid-20th century artifact scatter N=59	Recommended for Phase II testing

Table 3.8-2 Illinois Inventory of Archaeological Sites Entries Within the CPS Property (Sheet 10 of 10)

IIAS Site ID	Quadrangle	Site Type	NRHP Status
11DW336	Farmer City South	Multicomponent site; Isolated prehistoric lithic flake N=1; unassigned historic artifact scatter N=9	Recommended for Phase II testing
11DW337	Farmer City South	Mid-19th to mid-20th century artifact scatter N=185+	Recommended for Phase II testing
11DW338	Farmer City South	Early Archaic lithic scatter N=21	Recommended for Phase II testing
11DW339	Farmer City South	Late Archaic to Early Woodland lithic scatter N=12	Recommended for Phase II testing
11DW340	Farmer City South	Early to Middle Archaic lithic scatter N=23	Recommended for Phase II testing
11DW341	Farmer City South	Unassigned prehistoric lithic scatter N=4	Recommended for Phase II testing
11DW342	Farmer City South	Unassigned prehistoric lithic scatter N=6	Recommended for Phase II testing
11DW343	Farmer City South	Unassigned prehistoric lithic scatter N=2	Recommended for Phase II testing
11DW344	Farmer City South	Unassigned prehistoric lithic scatter N=4	Recommended for Phase II testing
11DW359	DeWitt	Unassigned prehistoric habitation site/lithic scatter N=9	Not eligible
11DW360	DeWitt	Late 19th to late 20th century artifact scatter N=6	Not eligible
11DW375	Farmer City South	Unassigned prehistoric lithic scatter N=14	Not reviewed/unassessed
11DW376	Farmer City South	Early Archaic lithic scatter N=9	Not reviewed/unassessed

Table 3.8-3 Illinois Inventory of Archaeological Sites Entries Within 6 Miles of CPS (Sheet 1 of 2)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
2357	Le Roy	Weldon Cemetery	Protected by HSRPA Burial Law
2378	DeWitt	Troutman Cemetery	Protected by HSRPA Burial Law
2382	DeWitt	Johnson Cemetery	Protected by HSRPA Burial Law
2388	DeWitt	Walters Cemetery	Protected by HSRPA Burial Law
2457	DeWitt	Griffith Cemetery	Protected by HSRPA Burial Law
2461	DeWitt	Barnes Cemetery	Protected by HSRPA Burial Law
2490	DeWitt	DeWitt Cemetery	Protected by HSRPA Burial Law
2595	Maroa	Rose Cemetery	Protected by HSRPA Burial Law
9129	Clinton	Coulter Cemetery	Protected by HSRPA Burial Law
9134	DeWitt	Lemen/Harp Family Cemetery	Protected by HSRPA Burial Law
11DW5	DeWitt	Prehistoric mound site	Protected by HSRPA Burial Law
11DW10	Maroa	Paleo habitation site	Unassessed Recommended for Phase II testing
11DW13	Maroa	Late Archaic habitation site	Unassessed
11DW14	Clinton	Unassigned Prehistoric site	Unassessed
11DW20	Farmer City South	Unassigned Archaic site N=25	Unassessed
11DW25	DeWitt	Early Archaic habitation site N=3	Unassessed
11DW26	DeWitt	Woodland habitation site	Unassessed
11DW27	DeWitt	Unassigned prehistoric habitation site N=16	Unassessed
11DW35	Farmer City South	Unassigned prehistoric habitation site N=82	Unassessed
11DW63	Maroa	Unassigned prehistoric lithic scatter N=4	Unassessed

Table 3.8-3 Illinois Inventory of Archaeological Sites Entries Within 6 Miles of CPS (Sheet 2 of 2)

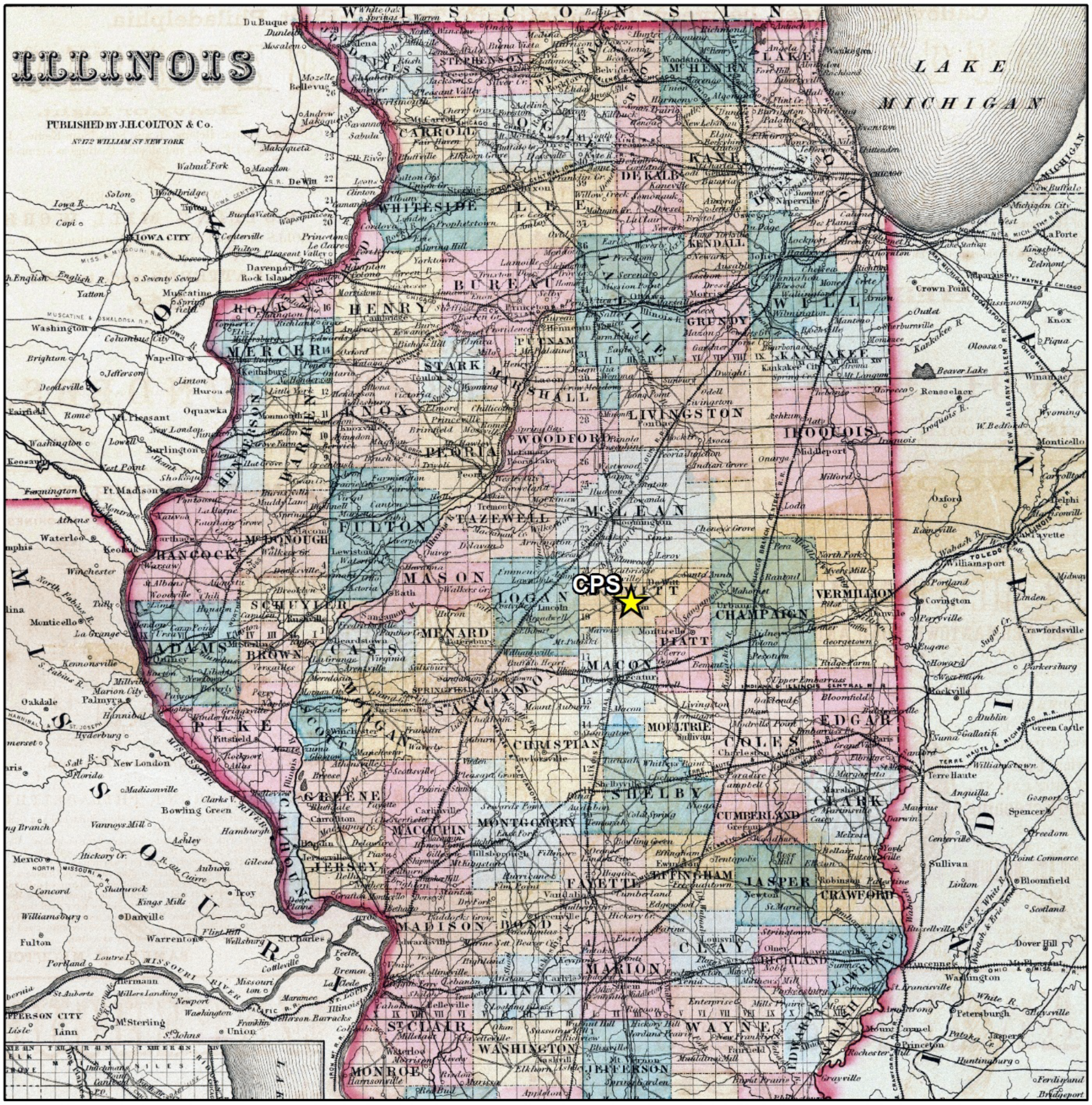
IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW95	Clinton	Unassigned prehistoric habitation site N=2	Unassessed
11DW96	Clinton	Unassigned Archaic processing camp N=2	Unassessed
11DW108	DeWitt	Unassigned prehistoric processing camp N=3	Unassessed
11DW109	DeWitt	Unassigned prehistoric habitation site N=3	Unassessed
11DW110	DeWitt	Unassigned prehistoric processing camp N=3	Unassessed
11DW189	DeWitt	Unassigned prehistoric lithic scatter	Unassessed
11DW239	DeWitt	Middle to Late Archaic lithic scatter	Unassessed
11DW274	Farmer City South	Middle to Late Archaic lithic scatter	Unassessed
11DW284	Maroa	Middle Archaic lithic scatter	Determined not eligible after Phase II testing
11DW285	Clinton	Unassigned historic period habitation site	Unassessed
11DW351	Maroa	An isolated find of one prehistoric core N=1	Not eligible
11DW352	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW353	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW354	Maroa	Early, Middle, and Late Archaic site N=67	Recommended for Phase II testing
11DW355	Maroa	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW356	Maroa	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW357	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW362	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW364	Maroa	Springhead and 1871 to 1945 artifacts N=5	Not eligible
11DW424	Clinton	Cundiff Cemetery with Markers 1840 to 1869	Protected by HSRPA Burial Law

Table 3.8-4 Historic Structures Entries Within 6 Miles of CPS

IHPD #	Historical Name	Historical Use	NRHP Status	Distance from CPS[a]
303254	Harp Township Hall	Community Building	Undetermined	1.74 miles
303255	Centenary Methodist Episcopal Church	Church	Undetermined	1.65 miles
303262	Prairie Center Methodist Church	Church	Undetermined	4.52 miles
303277	NA	Unidentified (possible church)	Undetermined	2.66 miles
303280	NA	Single Dwelling	Undetermined	2.70 miles
303282	Weldon Springs Conservation Area	Recreational Park	Undetermined	5.80 miles
303284	NA	Single Dwelling	Undetermined	5.81 miles
303294	Bank of Lane	Single Dwelling	Undetermined	3.64 miles
303295	Lane School	School	Undetermined	3.48 miles
303296	Prairie Center Methodist Church World War I Memorial	Memorial	Undetermined	4.54 miles
303299	Field Piece	Artillery Field Piece	Undetermined	5.84 miles
303300	World War II Memorial	Memorial	Undetermined	5.83 miles
303301	World War I Memorial	Memorial	Undetermined	5.82 miles
303302	Cyrus Hall Memorial Gate	Memorial	Undetermined	5.84 miles
303307	NA	Single Dwelling	Undetermined	3.59 miles

(IHPD 2022b)

a. Distances are approximate and based on the CPS Unit 1 center point and IHPD-HARGIS location data.



Legend

☆ CPS

Figure 3.8-1 Historical Illinois Topography Map 1855

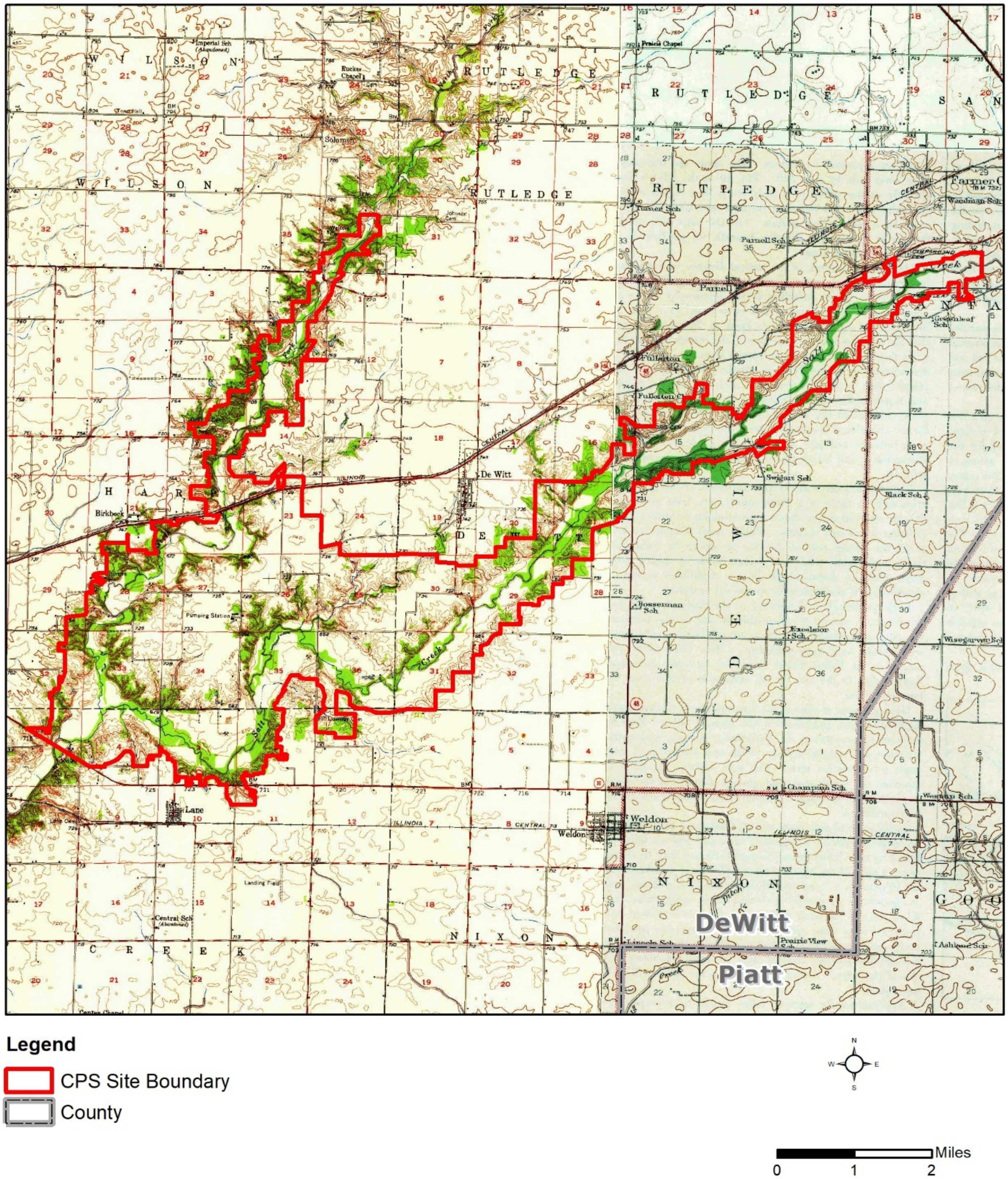


Figure 3.8-2 USGS 1:62,500 Topography Map from 1943–1957

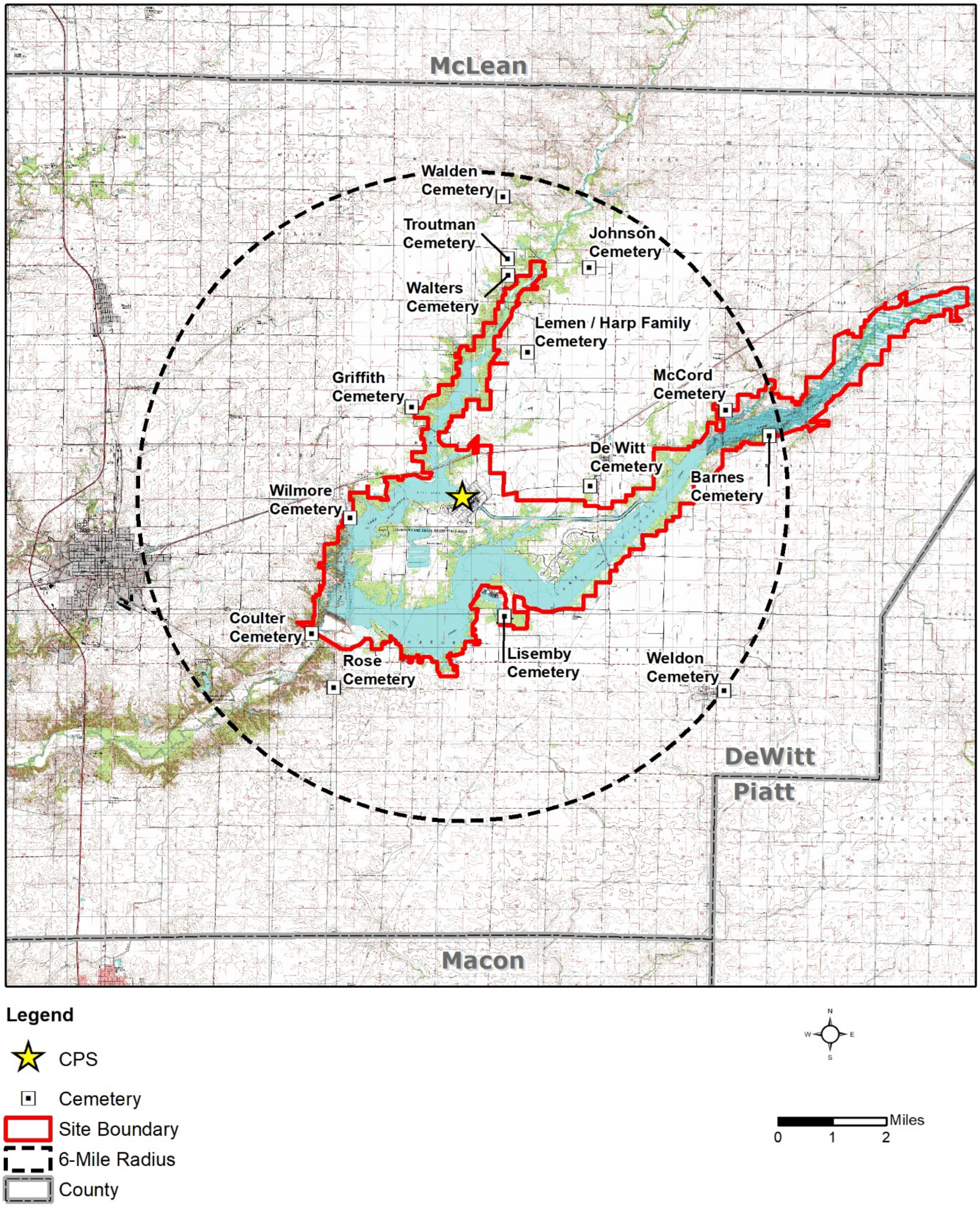


Figure 3.8-3 Unrestricted IIAS Cemeteries Within 6 Miles and the CPS Site Boundary

Figure 3.8-4 Construction Photograph of the CPS Site, 1976

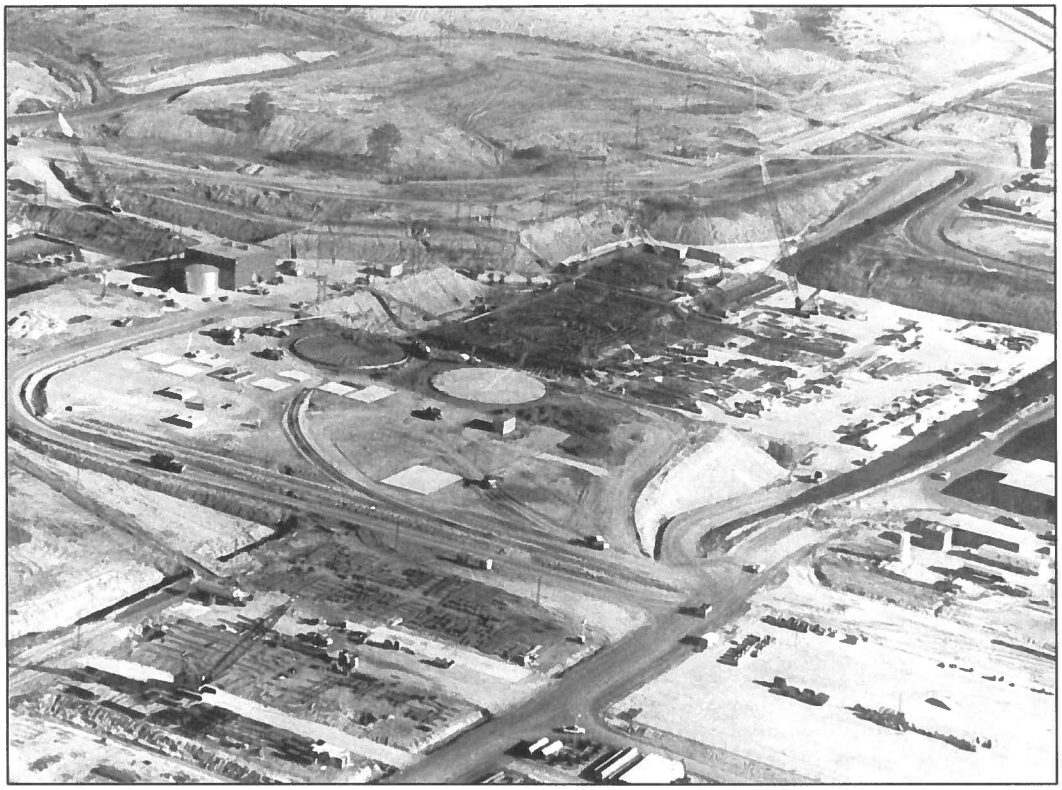


Figure 3.8-5 Construction Photograph of the CPS Site, 1976

Figure 3.8-6 Construction Photograph of the Clinton Lake Dam Looking East, 1977

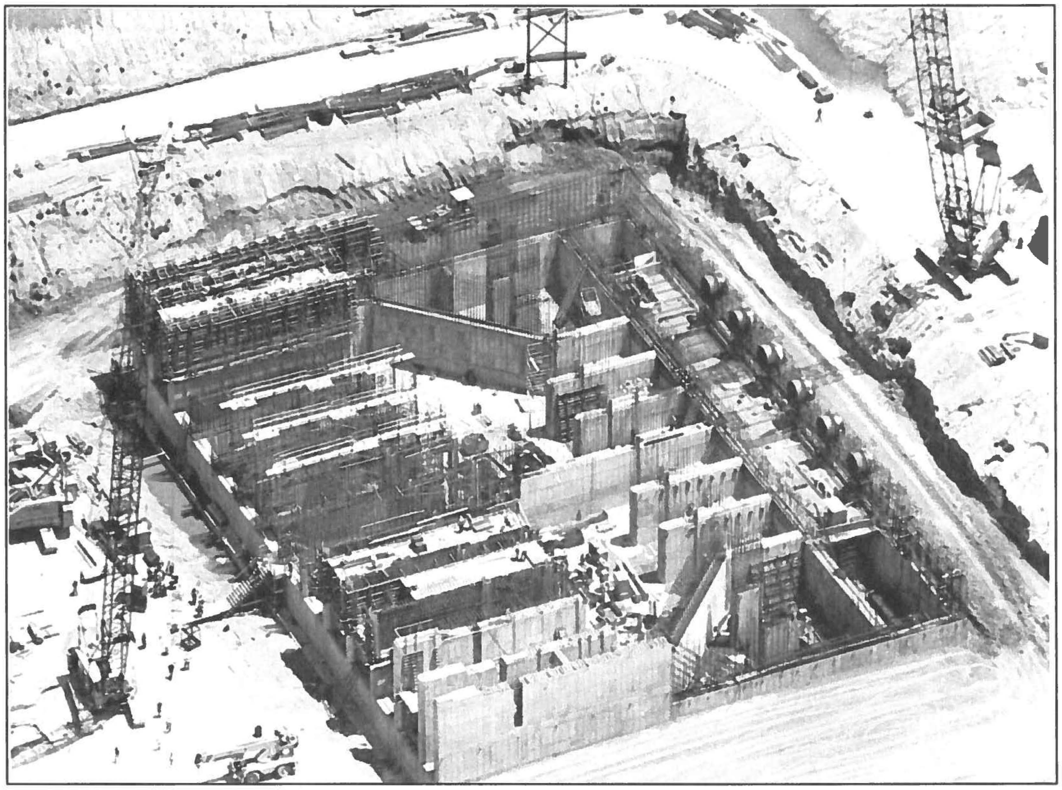


Figure 3.8-7 Construction Photograph of the CPS Site, 1977

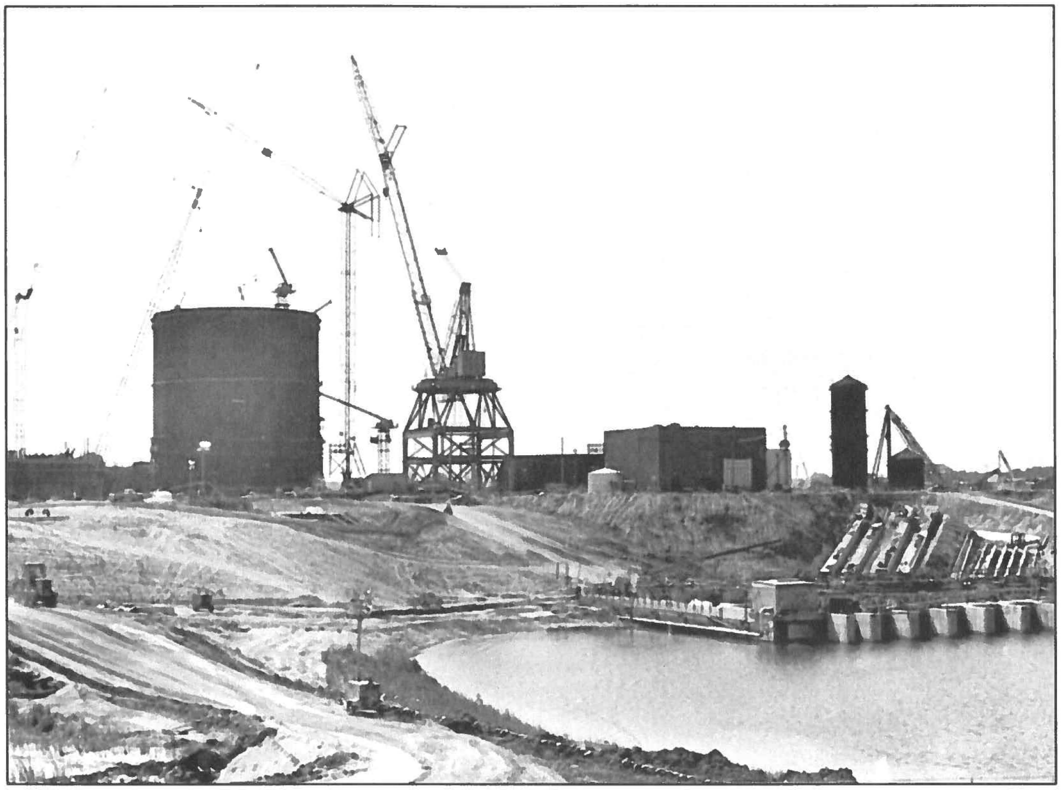


Figure 3.8-8 Construction Photograph of the CPS Site Looking Southwest, 1978

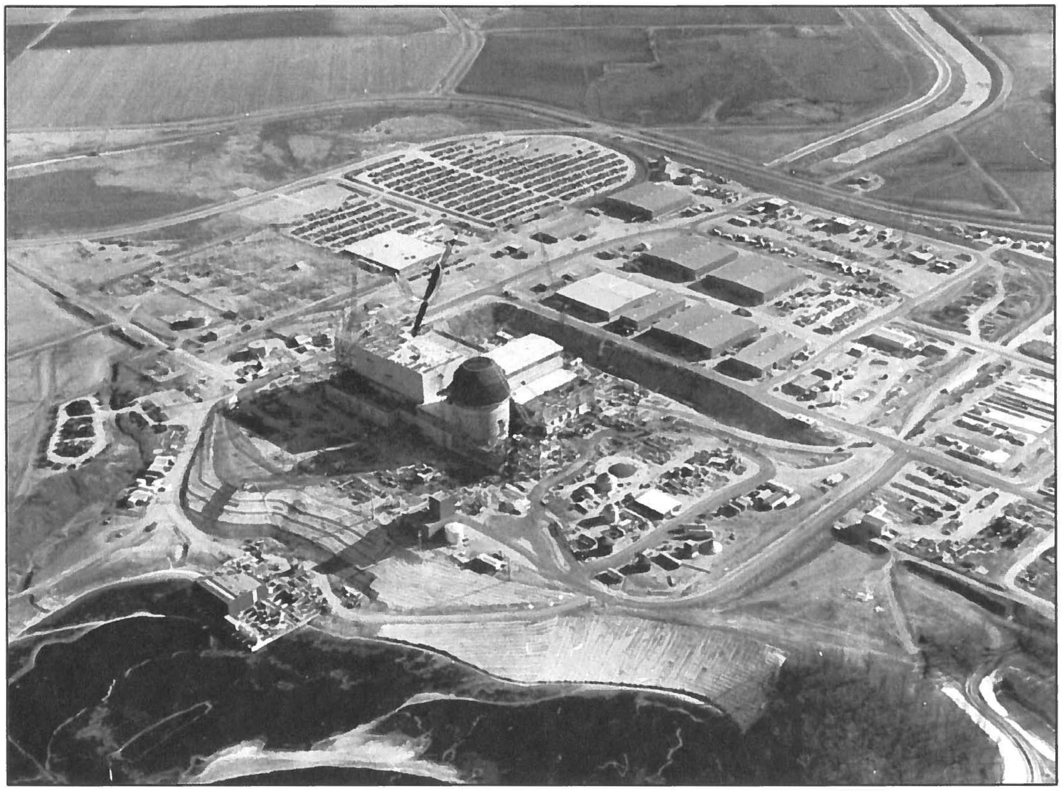


Figure 3.8-9 Construction Photograph of CPS Looking East, 1980

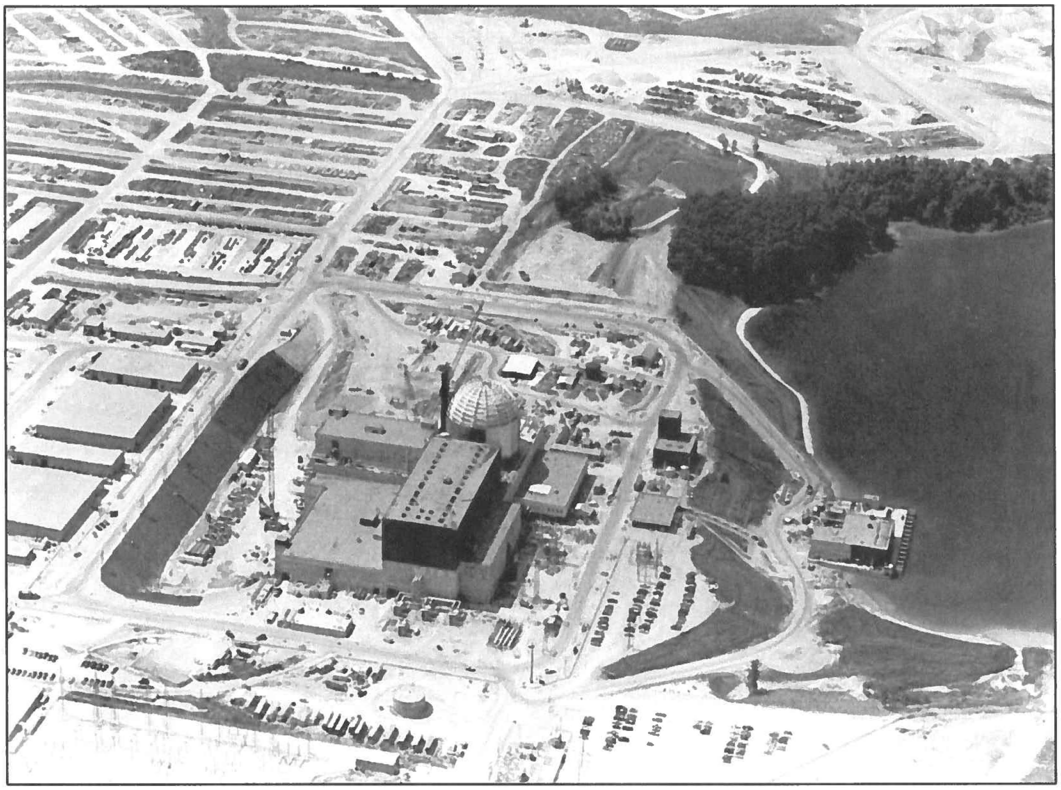


Figure 3.8-10 Construction Photograph of CPS Looking West, May 1982

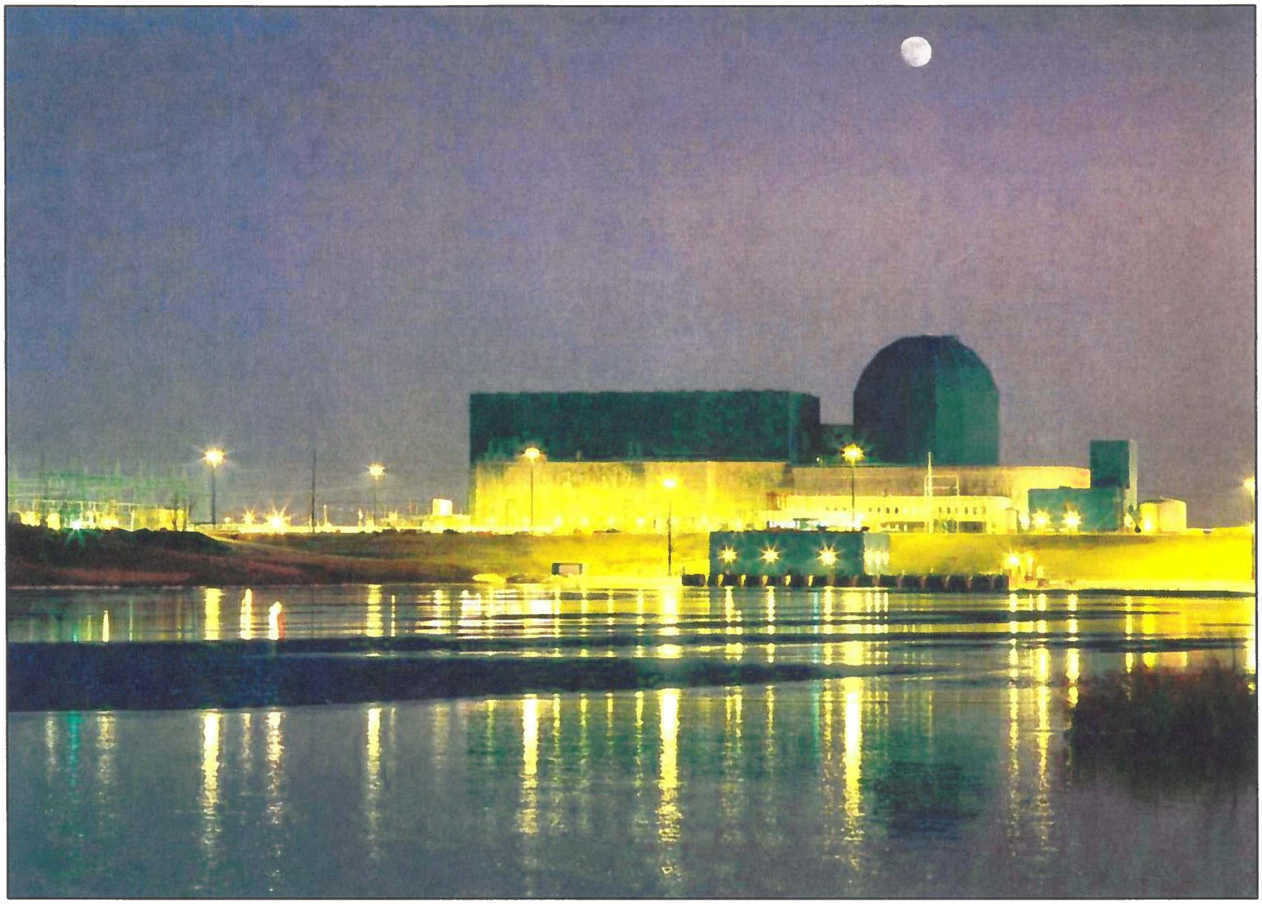


Figure 3.8-11 Post-Construction Photograph of CPS Looking Southeast, 1993

3.9 Socioeconomics

Socioeconomic descriptions are focused on DeWitt, McClean, and Macon Counties because approximately 70 percent of the CPS workforce resides in these counties, and because CPS pays taxes to DeWitt County. The remaining workforce is dispersed throughout the region (see Table 2.5-1).

CPS refueling and maintenance outages are on a 24-month cycle and last approximately 19 days. As presented in Section 2.5, during an outage there are typically an additional 1,097 contract employees on site. As seen in Figure 3.1-4, there are several nearby Illinois communities within the 50-mile radius of CPS, including Clinton, Decatur, Champaign, and Springfield, with numerous motel, campground, and food service conveniences available for contract workers, who provide temporary support during site outages. Transportation corridors such as I-57, state highways such as IL 54 and local roadways provide commuter access to CPS.

3.9.1 Employment and Income

DeWitt, McClean, and Macon Counties are the counties most influenced by CPS operation. Additionally, CPS is one of CEG's assets on which property taxes are paid to DeWitt County. As presented in Section 3.11.1, the populations of DeWitt and Macon Counties are expected to decrease through 2047 (the LR operating term), whereas the population of McLean County is expected to increase. Low-income populations and poverty thresholds for the counties are described in Section 3.11.2.

The estimated employed population in DeWitt County in 2021 was 7,065 persons. The leading reported occupational sector was government and government enterprises, with approximately 15.7 percent, or 1,108 persons employed. This was followed by retail trade, with 13.6 percent, or 960 persons, employed; and construction, with 7.6 percent, or 539 persons, employed. (BEA 2021) According to the DeWitt County Development Council, key businesses in DeWitt County include AMS Inc., Arcosa Inc, and McElroy Metal, among others (DCDC 2023). The annual payroll in DeWitt County was approximately $881.7 million in 2021, and the average wage per job was $63,938. In 2021, per capita personal income was $57,473. (BEA 2021) The annual average unemployment rate in DeWitt County declined steadily with minor fluctuations from 8.1 percent in 2012 to 4.2 percent in 2019. During the COVID-19 pandemic in 2020, the annual average unemployment rate rose to 6.8 percent, then declined to 4.0 percent in 2022. (BLS 2023)

Macon County's estimated employed population as of 2021 was 57,552. Manufacturing led the reported occupational sectors with 18.7 percent, or 10,748 persons, employed. Health Care and Social Assistance followed with 7,139 (12.4 percent), then Government and Government Enterprises, with 5,862 (10.2 percent) persons employed. Macon County's annual payroll for 2021 was roughly $5.8 billion, with an average wage per job of $62,232, and a per capita personal income of $56,548. (BEA 2021) Key employers in Macon County's largest city, Decatur, are Archer Daniels Midland, Caterpillar, and Decatur Memorial Hospital (EDC 2022). Like DeWitt County, Macon County's unemployment rate largely declined over the last decade, from 9.9 percent in 2012 to 5.0 percent in 2019. It spiked briefly to 10.0 percent in 2020 during the COVID-19 pandemic, then declined again to 5.5 percent in 2022. (BLS 2023)

For McLean County, the estimated employed population in 2021 was 109,584. The leading reported occupational sector for the county in 2021 was Finance and Insurance, with 21.7 percent, or 23,822 persons, employed. This was followed by Government and Government Enterprises at 13.7 percent (15,055 persons), and Health Care and Social Assistance at 9.6 percent, or 10,514 persons, employed. (BEA 2021) The top employers for McLean County in 2022 were State Farm Insurance, Illinois State University, and Rivian Automotive (TP 2022). The annual payroll for McLean County was approximately $10 billion. The average wage per job was $64,228, with a per capita personal income of $58,503. (BEA 2021) McLean County's unemployment rate has fluctuated little over the years, beginning at 6.4 percent for 2012, hitting a low of 3.6 percent in 2019 and a high of 6.9 percent during the COVID-19 pandemic, then declined to 3.5 percent at the end of 2022 (BLS 2023).

3.9.2 Housing

Between 2011 and 2021, DeWitt and Macon Counties saw decreases in population, whereas McLean County's population remained stable. See Table 3.11-2 for a description of the counties' population growth trends anticipated for the PEO.

As presented in Table 3.9-1, vacant housing unit availability rose between 2011 and 2021 in DeWitt County. In 2021, DeWitt County's available rental housing was an estimated 7.2 percent, and its available homeowner housing was an estimated 3.0 percent. Table 3.9-1 also shows DeWitt County experienced an increase in median housing values during the same time span, 5.2 percent, to a median value of 109,800. Between 2011 and 2022, median monthly rent grew by 21.3 percent in DeWitt County to $713. (USCB 2021)

In Macon County, total housing units decreased by 1.6 percent from 2011 to 2021. Available rental housing, however, grew by 5.2 percent, and available homeowner housing grew by 0.4 percent (see Table 3.9-1). Median housing values in Macon County increased by 20.7 percent between 2011 and 2021, to a median value of $110,800. Median rents increased by 16.3 percent, to a median monthly rent of $719. (USCB 2021)

Table 3.9-1 also presents housing data for McLean County, where the total number of housing units increased by 7.6 percent from 2011 to 2021. Homeowner and rental vacancies in McLean County both fell in the same time span, by 1.7 percent and 5.9 percent, respectively. Median housing values in McLean County rose by 14.8 percent to $183,300, and median monthly rents rose to $858, an increase of 22.2 percent. (USCB 2021)

3.9.3 Water Supply and Wastewater

In DeWitt County, water and wastewater are handled at the municipality level, with rural residents in unincorporated parts of the county relying on private wells, as the county does not provide or control these services. Groundwater is the source of 100 percent of DeWitt County’s water supply. Community sources for water in DeWitt County include seven municipalities: the city of Clinton, the village of DeWitt, Farmer City, the village of Kenney, the village of Wapella, the village of Waynesville, the village of Weldon, as well as Weldon Springs State Park, three mobile home parks, and DeWitt County Nursing Home. Combined, the seven municipal water suppliers supply 1,310,600 gallons of water to 12,380 customers daily. (IEPA 2022c) The largest of the seven water suppliers, the city of Clinton Water Department, produces roughly 900,000 gallons of water per day in a facility designed to produce 1.75 MGD, leaving ample room for system expansion (CCI 2022).

The IEPA has provided several suggested avenues for protecting the source water of the various water suppliers across DeWitt County. These include minimum protection zones, maximum setback zones, recommended contingency planning, proper abandonment or retrofitting of inactive wells, and reviews of cross connection control programs. (IEPA 2022c)

Sanitary sewer service is largely limited to incorporated areas of DeWitt County (SDD 2022). The city of Clinton, Farmer City, and the villages of DeWwitt, Kenney, Waynesville, and Weldon all feature a sewage treatment plant (IEPA 2022d).

Like DeWitt County, water services in Macon County are handled at the municipality level. The Water Production Division of the city of Decatur provides water services to the majority of Macon County residents. Lake Decatur serves as the primary water source, with the DeWitt County well field and a former sand and gravel pit near the South Water Treatment Plant as emergency sources. Water is treated through several facilities also operated by the city of Decatur. The City of Decatur’s main water needs focus is in improving water quality. The city recently completed a $92 million-dollar dredging project for Lake Decatur and authorized a long-term watershed management program to improve the lake’s water quality. (CDI 2022; IEPA 2022c).

Other than the City of Decatur, Macon County’s water sources are all groundwater wells. These include the village of Argenta (two wells), the village of Blue Mound (two wells), the village of Forsyth (three wells), Long Creek Township (two wells), the city of Macon (four wells), the city of Maroa (two wells), the village of Niantic (three wells), and the village of Warrensburg (three wells) (IEPA 2022c).

The Sanitary District of Decatur is the regional wastewater treatment authority for central Macon County. It provides wastewater treatment services to over 100,000 residents (over 97 percent of the county population) as well as several industrial and commercial users. (SDD 2022) The 2009 Macon County Comprehensive Plan states that the Sanitary District has the authority to provide its service anywhere in the county, and that it has excess capacity well into the near future. (CDI 2009) A more recent comprehensive plan for Macon County has not been published.

As in DeWitt and Macon Counties, McLean County water services are handled at the municipal level. The Water Division of the Public Works Department of the city of Bloomington provides water to all of Bloomington, the largest city in McLean County, as well as to 50 percent of the county residents outside of Bloomington. This division also provides sanitary sewer services. Bloomington's water supply, which is drawn from Lake Bloomington and Evergreen Lake, can continue to provide water during a drought of up to one year. The city of Bloomington also maintains a network of monitoring wells and has recently purchased land to begin the process of drilling for groundwater wells in order to add to the city's surface water supply. (CBI 2022) The water needs of the rest of the population of McLean County are served by several dozen groundwater wells, controlled by various municipalities, universities, housing divisions, and mobile home parks, as well as individual private wells. (IEPA 2022c)

The majority of sanitary sewer services in McLean County are provided by the Bloomington and Normal Water Reclamation District. The district operates conventional plants, which process over 24 MGD, as well as two experimental wetlands. (MW 2022)

Outside of incorporated areas, residents of all three counties rely on private septic systems to treat sewage and then discharge treated wastewater to the ground surface.

Section 3.6.3.1 describes the domestic water supply system of CPS, which is obtained directly from Clinton Lake for potable use and other cooling-related uses and treated on-site. Sanitary waste is treated at an on-site STP, as described in Section 3.6.1.2.3.

3.9.4 Community Services and Education

For DeWitt County, where CPS is located, law enforcement is provided through three agencies: DeWitt County Sheriff's Office, Clinton Police Department, and Farmer City Police Department. In Macon County, law enforcement is provided by the Macon County Sheriff's Office, as well as the police departments of Argenta, Decatur, Maroa, and Mt. Zion. The McLean County Sherriff's Department, 10 municipal police departments, and one university police department provide law enforcement services for McLean County. (USACOPS 2022)

DeWitt County residents are served by a combination of career and volunteer firefighters, as well as firefighters paid per call. There are five fire departments (FDs) consisting of one station apiece in DeWitt County, manned by 3 active career firefighters and 50 volunteer firefighters, with 60 firefighters paid per call. As in DeWitt County, residents of Macon County receive firefighting services from a combination of career and volunteer firefighters, with 12 departments, 19 stations, 112 career firefighters, 235 volunteer firefighters, and 48 firefighters paid per call. Twenty-four FDs consisting of a mix of career and volunteer firefighters serve McLean County, with 38 stations, 195 career firefighters, 400 volunteer firefighters and 177 firefighters paid per call. (USFA 2022)

DeWitt County has two public school districts, Blue Ridge Community Unit School District (CUSD) and Clinton CUSD. Based on the 2020−2021 school year, there were seven total schools in the county and 2,322 total students between the districts, including student enrollment for one additional school that is part of Blue Ridge CUSD but located in Piatt County. (NCES 2022) There is one private school in the county, with 19 total students; however, this school does not appear in the National Center for Education Statistics database (PSR 2022). There are 10 school districts with 44 schools and 15,795 students in Macon County, as of the 2020–2021 school year. Additionally, for the 2019–2020 school year, there were nine private schools serving 1,463 students. Lastly, McLean County features 13 school districts, 61 schools and 24,202 students as of the 2020–2021 school year. There are 2,073 students in nine private schools in McLean County as of the 2019–2020 school year. (NCES 2022)

Deland/Weldon CUSD 57 is notable as a jurisdiction that receives a portion of CPS's yearly tax payments as well. Deland/Weldon CUSD 57, in nearby Piatt County, is comprised of 3 schools and 179 students (NCES 2022). Within the 50-mile region of CPS, there are nine public and private 4-year higher education institutions. There are five public 2-year higher education institutions and no private 2-year institutions. (NCES 2022)

According to the U.S. Department of Health and Human Services, there are seven hospitals with a total of 759 inpatient beds within a 30-mile radius of DeWitt County. Warner Hospital is the only hospital located in DeWitt County, with a total of 23 inpatient beds. (HCRC 2022; HHS 2022)

3.9.5 Local Government Revenues

CEG pays annual property taxes to DeWitt County on behalf of CPS. CEG paid a total of roughly $13.5 million in property taxes for fiscal year (FY) 2021. Due to the recency of the ownership change, EGC remains the listed owner on tax records as of April 2023.

See Table 3.9-2a for a breakdown of CPS's tax payments and the percent of total DeWitt County revenues that they represent for years 2018−2022. DeWitt County's total general revenues for FY 2021, the latest year for which an annual financial report is available, were $8.03 million (DC 2021). That same year, tax payments made by CPS and retained by DeWitt County in FY 2021 were $1.83 million, which comprised 22.8 percent of DeWitt County's total revenues that year (DC 2021).

As reflected in Table 3.9-2a, DeWitt County's total revenues remained stable in FY's 2018, 2019 and 2020. In FY 2021, DeWitt County's revenues saw an increase to over $8 million, largely due to additional monies received from the Rebuild Illinois Bond Program, as well as an increase in CPS property tax payments, described later in this section. In FY 2021, DeWitt County expenditures included general government activities, public safety, highways and streets, health, and culture and recreation (DC 2022).

DeWitt County retains a portion of the taxes and disperses the remaining revenues to various local entities. The largest portion of CPS's tax payments, approximately $8.9 million, were dispersed to Clinton CUSD #15. Richland Community College in nearby Macon County received $1.35 million, and Parkland College in Champaign County received $30,000. Nearby school systems Deland/Weldon CUSD and Blue Ridge CUSD received approximately $184,000 and $92,000, respectively. See Table 3.9-2b for a breakdown of the amount of CPS tax payments distributed to local schools and colleges by DeWitt County for FY 2018–2022. Additional entities to which DeWitt County distributes portions of CPS tax payments include Harp Township, Harp Road District, local FDs, libraries, and ambulance districts.

CPS's property tax payments were stable from the years 2018−2020, remaining roughly between $12.7 and $12.9 million, as seen in Table 3.9-2a. CPS's property tax payment increase in FY 2021 was due to a new 7-year tax agreement between CPS and several local tax jurisdictions specifically regarding the two power block parcels of CEG's property. This mutual agreement allows both CEG and taxing jurisdictions to set long term budgets without volatility, capping the maximum total tax at $90 million. The agreement, which lasts through FY 2027, sets the assessed value each year, as well as an amount of actual tax each year. A credit would be triggered if the levy results in a tax over the agreed upon amount. CEG does not anticipate any changes in state or local tax laws, rates, or assessed property value, or any other adjustments that could result in notable future increases or decreases in property taxes.

CPS makes an annual payment of $1.9 million to the Illinois Emergency Management Agency to fulfill obligations under the Illinois Nuclear Safety Preparedness Act. These payments assist the state and local jurisdictions in preparing and implementing plans to deal with the effects of nuclear accidents. Additionally, CPS makes a moderate number of annual payments to local FDs. In 2021, these payments were as follows: $119,000 to Clinton FD, $15,000 to Farmer City FD, and $17,600 to Kenney FD.

CPS makes several charitable donations to a variety of foundations every year. In 2021 and 2022, modest donations were made, but not limited to: Heartland Community College Foundation, The Write Stuff for Kids, Easter Seals DuPage and the Fox Valley Region, and the Community Foundation of Macon County.

3.9.6 Transportation

As discussed in Section 3.1.1, the primary road network in the area is shown in Figure 3.1-3 and Figure 3.1-4. The IL 54 provides commuter access to the station from the north and traverses the area southwest towards Springfield, Illinois, and northeast to Onarga, Illinois, where it merges with I-57. Access and egress to the site by road is limited by Clinton Lake, which encloses CPS to the east, south, and west. Commuters from the northwest would exit directly onto Power Road before merging with DeWitt Road, which provides direct access to the station. Also providing access to the station is Wren Road, which runs parallel to Power Road and intersects with DeWitt Road to the south and IL 54 to the north, providing commuters from the northeast with station access. The intersection of Power Road and IL 54 has a dedicated turn lane, but the intersection of Wren Road and IL 54 does not.

Commuters from the south would take Illinois Route 10, which traverses the area from Champaign, Illinois, east of the station to Lincoln, Illinois, west. Commuters would then turn north onto Friends Creek Road to cross Clinton Lake before turning east onto Old Clinton Road/DeWitt Road. Travelers would take a hard left to stay on DeWitt Road, which provides direct access to the station from the east.

The U.S. Transportation Research Board developed a commonly used indicator called level of service (LOS) to measure how well a road accommodates traffic flow. LOS is a qualitative assessment of traffic flow and how much delay the average vehicle might encounter during peak hours. LOS categories are listed and defined in Table 3.9-4.

The Illinois Department of Transportation (IDOT) average annual daily traffic (AADT) volumes for state roads that link to CPS are listed in Table 3.9-3. On IL 54 north of the station, the most recent AADT count was 1,750 in 2021. Wren Road east of Power Road and south of IL 54 had a 2021 AADT count of 75. DeWitt Road, which also provides access to Clinton Lake State Recreation area, had a 2021 AADT count of 500. (IDOT 2022a; IDOT 2022b)

To provide an evaluation of LOS for IL 54 and DeWitt Road, the known AADT traffic volumes were compared to the estimated capacity of a two-lane highway, as presented in the U.S. Transportation Research Board Highway Capacity Manual. The manual notes that the capacity of a two-lane highway under base conditions is 1,700 passenger cars per hour in one direction. Based on the IDOT AADT recorded volumes, the IL 54 traffic count north of the station would have a reported flow rate of approximately 36 passenger cars per hour per lane (pc/h/ln). Wren Road would have a reported flow rate of less than 2 pc/h/ln, and DeWitt Road east of the station would have a flow rate of approximately 10 pc/h/ln. Because the base condition capacities for a two-lane highway are not exceeded by the current average traffic conditions, there should be ample traffic capacity on all roads in the vicinity of CPS that provide commuter access. All three of these areas should fall within the LOS "A" to "C" range of conditions (Table 3.9-4). (IDOT 2022a; IDOT 2022b)

The 2018 DeWitt County Comprehensive Plan highlights the region's connectivity and focuses the county's transportation plans on maintenance to maintain this connectivity, with new roads built to link new development, as needed (DC 2018). The IDOT has several new mass transit projects, as well as improvements to existing mass transit projects, planned through FY 2024. Due to the rural nature of CPS and focus of the mass transit projects on large metropolitan areas in Illinois such as Chicago, these projects are not likely to have an impact on CPS commuters. There are no other known ongoing or planned STIP projects in DeWitt County in the near future (IDOT 2022c). The Alta Farms Wind Project, a Wind Energy System Facility currently under construction in DeWitt County, would cause various road closures in and around Clinton during the construction phase of the project (EGP 2022).

3.9.7 Recreational Facilities

DeWitt County features roughly 10,000 acres of parks and open space (DC 2018). A list of federal, state, and local lands that fall within the CPS vicinity can be found in Table 3.1-1. Data for percentage of use was not available for these facilities.

Weldon Springs State Park in DeWitt County is located southeast of Clinton and features 550 acres of trails, camping, fishing, and other outdoor activities (IDNR 2022b). Within the CPS site is Clinton Lake State Recreation Area, totaling 9,300 acres including Clinton Lake. Several recreational facilities and sites are available to the public in the recreation area, including boating, hunting, picnics, and playgrounds. Recreational facilities at Clinton Lake and the surrounding lands are managed by IDNR. (IDNR 2022a) Clinton Lake itself is totally within the CPS property boundary (EGC 2020a). Also located in DeWitt County is the Birkbeck State Habitat Area, managed by the IDNR, which provides permanent habitat for ring-necked pheasants, as well as hunting opportunities. (IDNR 2022h)

There are no National Parks in Illinois; however, the National Parks Service operates the Lincoln Home, a national historic site in nearby Springfield, Illinois (NPS 2022a). East of Peoria, Illinois, is the Farmdale Reservoir Recreation Area, managed by the USACE. The area functions as an emergency reservoir to protect the area from flooding and is typically dry throughout the year, offering recreational amenities such as hiking, horseback riding, and mountain biking. (USACE 2022)

Clinton Lake State Recreation Area, Weldon Springs State Park, and the privately owned Arrowhead Acres Campground offer a total of 399 sites for RV camping (AAC 2022; IDNR 2022a; IDNR 2022e). East of the CPS main site is a private beach area and boat ramp available for use to current and former CPS employees, informally known as "The Point." This area is closed off from public access via a locked gate. Usage of this area is not tracked.

CPS previously featured a visitor center that was closed due to lack of use, briefly rented out as office space to IDNR, then demolished in 2018. Public visitation for CPS is generally limited to the annual open house. Approximately 300 people attended the open house in 2018 and 2019, and 200 attended in 2022. No open house was held in the years 2020 and 2021 due to the COVID-19 pandemic.

Table 3.9-1 Housing Statistics for DeWitt, Macon, and McLean Counties

Name	2011	2021	2011 to 2021 Change (%)
DeWitt County			
Total Housing Units	7,523	7,350	-2.3
Occupied Units	6,728	6,635	-1.4
Vacant Units	795	715	-10.1
Homeowner Vacancy (percent)	1.3	3.0	1.7
Rental Vacancy (percent)	6.1	7.2	1.1
Median House Value ($)	104,400	109,800	5.2
Median Rent ($/month)	588	713	21.3
Macon County			
Total Housing Units	50,471	49,687	-1.6
Occupied Units	45,624	43,914	-3.7
Vacant Units	4,847	5,773	19.1
Homeowner Vacancy (percent)	1.1	1.5	0.4
Rental Vacancy (percent)	6.0	11.2	5.2
Median House Value ($)	91,800	110,800	20.7
Median Rent ($/month)	618	719	16.3
McLean County			
Total Housing Units	69,749	75,084	7.6
Occupied Units	61,576	69,263	12.5
Vacant Units	8,173	5,821	-28.8
Homeowner Vacancy (percent)	2.4	0.7	-1.7
Rental Vacancy (percent)	11.4	5.5	-5.9
Median House Value ($)	159,600	183,300	14.8
Median Rent ($/month)	702	858	22.2

(USCB 2021)

Table 3.9-2a CPS Property Tax Payments, FY 2018–2022

Year	Total CPS Property Tax Payment	Amount of Property Tax Payment Retained by DeWitt County	Total DeWitt County General Revenues	CPS % of Total County Revenues
2018	$12,729,000	$1,776,000	$6,813,000	26.1%
2019	$12,900,000	$1,787,000	$6,798,000	26.3%
2020	$12,752,000	$1,792,000	$6,770,000	26.5%
2021	$13,517,000	$1,832,000	$8,025,000	22.8%
2022	NYA[a]	NYA	NYA	NYA

Numbers rounded to nearest thousand
a. NYA = Not Yet Available
(DC 2019; DC 2020; DC 2021; DC 2022)

Table 3.9-2b CPS Tax Payment Distribution to Local Colleges and School Districts

Year	Clinton CUSD	Deland/Weldon CUSD	Blue Ridge CUSD	Richland Community College	Parkland Community College
2018	$8,369,000	$182,000	$92,000	$1,231,000	$30,000
2019	$8,390,000	$182,000	$94,000	$1,251,000	$31,000
2020	$8,360,000	$186,000	$94,000	$1,226,000	$31,000
2021	$8,922,000	$184,000	$92,000	$1,351,000	$30,000
2022	NYA[(a)]	NYA	NYA	NYA	NYA

Numbers rounded to nearest thousand
a. NYA = Not Yet Available

Table 3.9-3 Total Average Daily Traffic Counts Near CPS

Route	Location	2012	2017	2021
IL-54	North of CPS	1,550	3,200	1,750
DeWitt Road	East of Wren Road	350	350	500
Wren Road	East of CPS	50	50	75

(IDOT 2012; IDOT 2017; IDOT 2021; IDOT 2022a; IDOT 2022b)

Table 3.9-4 Level of Service Definitions

Level of Service	Conditions
A	Free flow of the traffic stream; users are mostly unaffected by the presence of other vehicles.
B	Free flow of the traffic stream, although the presence of other vehicles becomes noticeable. Drivers have slightly less freedom to maneuver.
C	The influence of the traffic density on operations becomes marked and queues may be expected to form. The ability to maneuver with the traffic stream is clearly affected by other vehicles.
D	The ability to maneuver is severely restricted due to traffic congestion. Travel speed is reduced by the increasing volume. Only minor disruptions can be absorbed without extensive queues forming and the service deteriorating.
E	Operations at or near capacity – an unstable level. The densities vary, depending on the free-flow speed. Vehicles are operating with the minimum spacing (or gaps) for maintaining uniform flow. Disruptions cannot be dissipated readily, often causing queues to form and service to deteriorate to LOS F.
F	Forced or breakdown of flow. It occurs either when vehicles arrive at a rate greater than the rate at which they are discharged or when the forecast demand exceeds the computed capacity. Queues form behind these breakdowns. Operations within queues are highly unstable, with vehicles experiencing brief periods of movement followed by stoppages.

3.10 Human Health

This section describes site conditions likely to contribute to the occurrence of pathogenic thermophilic microbiological organisms; methodology and procedures designed to meet the regulatory requirements and standards for limiting potential induced current hazards arising from energized in-scope transmission lines; and a description of the station's radiological health environment and preventative measures necessary to reduce potential exposure levels to station workers and visitors during station operations.

3.10.1 Microbiological Hazards

In the GEIS, the NRC considered health impacts from thermophilic microorganisms posed to both the public and station workers because ideal conditions for thermophilic microorganisms can result from nuclear facility operations and discharges. Microorganisms of particular concern include several types of bacteria (*Legionella* species, *Salmonella* species, *Shigella* species, and *Pseudomonas aeruginosa*) and the free-living amoeba *Naegleria fowleri*. The public can be exposed to the thermophilic microorganisms *Salmonella*, *Shigella*, *P. aeruginosa*, and *N. fowleri* during swimming, boating, or other recreational uses of freshwater. If a nuclear plant's thermal effluent enhances the growth of thermophilic microorganisms in waters open for recreational use, recreational users could experience an elevated risk of exposure when using waters near the plant's discharge. (NRC 2013a; NRC 2020a)

Legionella occurs naturally in freshwater environments, like lakes and streams but generally is not present in sufficient numbers to cause disease. It can become a health concern when it grows and spreads in human-made building water systems, such as cooling towers. *Legionella* optimally grow in stagnant surface waters with biofilms or slimes that range in temperature from 77°F to 113°F. *Legionella* is transmitted via inhalation of aerosolized water containing the bacteria. Less commonly, *Legionella* can also be transmitted via aspiration of drinking water. (CDC 2018; CDC 2021)

N. fowleri grows best at higher temperatures up to 115°F and can survive for short periods at higher temperatures. *N. fowleri* is naturally found in warm freshwater environments such as lakes and rivers, naturally hot (geothermal) water such as hot springs, warm water discharge from industrial or power plants, geothermal well water, poorly maintained or minimally chlorinated swimming pools, water heaters, and soil, where it lives by feeding on bacteria and other microbes in the environment. Sampling of lakes in the southern tier of the United States, where *N. fowleri* is more likely to be found, indicates that *N. fowleri* is commonly present during the summer. Attempts have been made to determine what concentration of *N. fowleri* in the environment poses an unacceptable risk. However, no method currently exists that accurately and reproducibly measures the numbers of amebae in the water. (CDC 2022)

N. fowleri infection in humans is known as Primary Amebic Encephalitis (PAM). PAM is a rare disease. Infections occur when *N. fowleri* penetrates the nasal tissue through direct contact with water in warm lakes, rivers, or hot springs and migrates to the brain tissues. Hundreds of millions of visits to swimming venues occur each year in the United States that result in 0-8 infections per year. From 1962−2021, 154 infections in the United States have been reported to the U.S. Centers for Disease Control and Prevention (CDC) with none occurring in Illinois. Nearly half of the infections have occurred in Florida and Texas. Infections have occurred in a few northern states. CDC initiated a free-living ameba laboratory and PAM registry in 1978, and the CDC reports that the rate of infections is not increasing. (CDC 2022).

The other human pathogens mentioned above have infection routes of contact with infected persons or contaminated water, food, soil, or other contaminated material. The exposure route of concern would be contact with contaminated water containing a population of microorganisms sufficient for human infection. The pathogens can grow at a range of temperatures, but as human pathogens, have an optimal growth temperature around the human body temperature. The most current data from CDC for waterborne illness outbreaks in untreated recreational water is from 2013−2014. The 2013−2014 data identifies water-associated outbreaks in Illinois as skin illnesses related to uroshiol/poison ivy in untreated recreational water. (CDC 2019).

As discussed in Section 2.2, CPS uses a once-through cooling water system that withdraws water from the Clinton Lake into its condensers. After the water cools the condensers, the heated water is not cycled back to the condensers but released back into the Clinton Lake via the discharge flume. The heated water can also be pumped from the discharge flume into cooling towers installed along the discharge flume and returned back to the discharge flume. The cooling towers were installed not to recycle cooling water through the condensers but for use during warmer months to ensure compliance with the NPDES permit thermal limits for discharge into Clinton Lake. The NDPES permit limits the temperature of the discharge at the second drop structure of the discharge flume which is the point at which the flow in the discharge flume is released into Clinton Lake to a daily average temperature which (1) does not exceed 99°F (daily average) during more than 90 days in a calendar year, and (2) does not exceed 110.7°F for any given day (daily average maximum) (Attachment B). As the discharge mixes with the lake water temperatures, the lake water temperature will attenuate. A thermal study conducted in 2015 associated with CPS's CWA 316(a) Demonstration looked at July 2015 temperatures across Clinton Lake. The lake temperature at the nearest boat ramp, Weldon Day Use and Boat Access Area, is characterized as approximately 95°F and the lake temperature at the Clinton Lake State Recreation Area campground beach area is characterized as approximately 90°F.

Clinton Lake is open to the public for a variety of water sports including swimming, diving, water skiing, and boating. Buoys restrict approach the public to the intake and the discharge structures. The lake hosts the Clinton Lake State Recreation Area which provides a beach area, campsites, multiple boat ramps, and a marina. (IDNR 2022a)

Exposure to *Legionella* spp. from power plant operations is a potential problem for a subset of the workforce. Station personnel most likely to come into contact with *Legionella* aerosols would be those who dislodge biofilms, where *Legionella* are often concentrated, such as during the cleaning of condenser tubes and cooling towers (NRC 2013a). CPS has two banks of MDCTs adjacent to the station-end of the discharge flume. The cooling towers are operated during summer months (typically May−September). The cooling towers are maintained by a qualified contractor. The water that circulates through the cooling towers is treated with disinfectants and water treatment chemicals to prevent scaling and corrosion prior to its introduction into station systems.

CEG has a comprehensive health and safety program with procedures that implement industrial hygiene practices including appropriate personal protective equipment as appropriate for hazards and entry into confined spaces to minimize the potential for station worker exposure. CPS previously participated in the OSHA Voluntary Protection Program and has recently applied to participate in the program again. An initial inspection by OSHA is pending.

3.10.2 Electric Shock Hazards

The electric field created by high-voltage lines can extend from the energized conductors on the lines to other conducting objects, such as the ground, vegetation, buildings, vehicles, and persons if appropriate clearances are not maintained, posing a shock hazard for the public and workers. To minimize the shock that could be experienced by someone touching an object that is capacitively charged, the clearance between the power lines and the object must limit the induced current to a low enough electrical charge. The National Electrical Safety Code (NESC) contains the basic provisions considered necessary for the safety of workers and the public.

The in-scope transmission lines at CPS are located onsite and within the station's developed area. Figure 2.2-2 shows the lines on an aerial figure. The in-scope transmission lines include the 345-kV lines between the nuclear power block and the 345-kV switchyard, which connects the generating unit to the regional grid owned and operated by Ameren and the 138-kV line owned and operated by Ameren that provides power to the ERAT. This 138-kV line spans a short distance on site that generally parallels the power block and lies between the power block and Clinton Lake. The 345-kV lines and the 138-kV line are within fenced and/or barricaded areas within CPS's owner-controlled area.

The in-scope transmission lines were designed to meet the requirements of the NESC in effect at the time of construction. Per Section 0.13.B.2 of the current Code, (2017), existing installations, including maintenance and replacement that currently comply with prior editions of the Code, need not be modified to comply with these rules except as may be required for safety reasons by administrative authority. The 345-kV lines that span from the transformers inside the power block to the 345-kV switchyard are within areas that NESC define as an electrical supply station (Part 1 of the NESC titled "Safety Rules for the Installation and Maintenance of Electric Supply Stations and Equipment"). The NESC 5 milliamperes (mA) threshold for induced shock is not applicable for areas within the electrical station accessible to qualified persons. CEG has an electrical safety procedure to govern work on and within these electrical equipment areas.

Work at CPS is governed by a comprehensive industrial safety program consisting of a safety handbook and topic and task-specific procedures. CEG uses and follows the OSHA standards for electric power generation, transmission, and distribution (29 CFR 1910.269). The CPS electrical safety program addresses proper clearances and safe work approaches and use of mobile equipment for safe placement and operation. CPS also has procedures that address grounding of vehicles, equipment, and structures. CPS has a workplace hazards identification process that performs jobsite analysis of workplace hazards, focusing on mitigation activities to eliminate risk and potential for both injury and human error. When working on or near the energized overhead lines under the responsibility of CEG, the work follows the guidance specified in the fleet electrical safety procedure for overhead power lines and hazardous induced voltages. The fleet electrical safety procedure was developed to comply with the National Fire Protection Association Electrical Safety in the workplace standard and applicable NESC standards.

The 138-kV line to the ERAT is an Ameren transmission line. Typically, 138-kV lines do not come even close to the 5-mA steady-state current due to electrostatic effects threshold of the NESC clearance standard. This line has phase-to-phase (rather than phase to ground) 138-kV voltage between line conductors. For this 138-kV line, including Ameren's overvoltage factor of eight percent for the total of 149-kV, the phase-to-ground voltage is approximately 86-kV. This is less than 98-kV threshold required by the NESC to have increased clearances due to the potential for induced current greater than 5 mA. Hence, this transmission line does not fall into the category of reaching 5 mA steady-state current.

3.10.3 Radiological Hazards

As required by NRC regulations at 10 CFR 20.1101, "Radiation protection programs," CEG designed a radiation protection program to protect onsite personnel (including employees and contractor employees), visitors, and offsite members of the public from radiation and radioactive material at CPS. NRC regulations require that gaseous and liquid radioactive releases from nuclear power plants must meet radiation dose-based limits specified in 10 CFR Part 20, "Standards for Protection Against Radiation," and the ALARA criteria in 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." Through these release limits, the NRC places regulatory limits on the radiation dose that members of the public can receive from a nuclear power plant's radioactive effluent. CEG uses its ODCM, which contains the methods and parameters for calculating offsite doses resulting from liquid and gaseous radioactive effluents. These methods ensure that radioactive material discharges from CPS meet NRC and EPA regulatory dose standards.

CPS's annual radioactive effluent release reports (ARERRs) contain a detailed presentation of the releases from CPS and the resultant calculated doses. For 2018−2022, CPS operations were well within these federally required limits. Also, there were no abnormal liquid or gaseous releases from 2018−2022. (EGC 2019b; EGC 2020c; EGC 2021a; EGC 2022b; CEG 2023b). During 2021, the maximum annual radiation dose delivered to the inhabitants of the area surrounding CPS, due to radioactivity released from the station, was 0.0337 millirem (mrem) and it was 0.311 mrem in 2022. The radiation dose to the public in the vicinity of CPS was calculated by using the concentration of radioactive nuclides from each gaseous effluent release coupled with historical weather conditions. The dose from CPS gaseous radioactive effluents is only a small fraction of the limit for the maximum exposed member of the public, less than 1 percent in 2021 and approximately 2 percent in 2022. CPS is licensed to release radioactive liquid effluents in a batch mode: however, as a matter of station management commitment, CPS strives to be a zero radioactive liquid release plant. The last radioactive liquid release occurred in September 1992. As such, there was no dose received by the public from the liquid radioactive effluent pathway in 2021 or 2022. (EGC 2022b; CEG 2023b)

CPS's REMP provides additional assurance that there are no significant dose or radiological environmental impacts due to operations of the plant. The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: surface water, drinking water, well water, fish, sediment, air particulates, air iodine, milk, food products, grass, direct radiation. The REMP results for 2021 and 2022 are presented in Table 3.10-1. In assessing all the data gathered for 2021 and 2022 and comparing these results with preoperational data, CEG concluded that the operation of CPS had no adverse radiological impact on the environment. (EGC 2022a; CEG 2023a)

In addition to the REMP, CPS has an onsite groundwater protection program designed to monitor the onsite station environment. Results for 2021 and 2022 are presented in Table 3.10-2.

The NRC monitors occupational exposure at nuclear power plants. The 3-year (2018–2020) average occupational dose per individual (total effective dose equivalent [TEDE]) was 0.092 rem for CPS and 0.115 rem for BWRs. The annual TEDE limit is 5 roentgen equivalent man (rems) [10 CFR 20.1201(a)(1)]. CPS had a 3-year (2018–2020) TEDE collective dose per reactor of approximately 83.287 person-rem. In comparison, the average annual collective dose per reactor for BWRs was 105.881 person-rem. (NRC 2022b)

Table 3.10-1 REMP Sample Results (Sheet 1 of 2)

Media	Parameter	2021 Result	2022 Result
Surface water	Iodine-131	None detected	None detected
	Tritium	None detected	None detected
	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Drinking water	Gross Beta	None detected	None detected
	Tritium	None detected	None detected
	Iodine-131	None detected	None detected
	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Well water	Tritium	None detected	None detected
	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Fish	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Shoreline sediment	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Air particulates	Gross Beta	Within 1 mile of CPS 20 E-3 pCi/m^3 1-5 miles 19 E-3 pCi/m^3 Control 20 E-3 pCi/m^3	Within 1 mile of CPS 20 E-3 pCi/ m^3 1-5 miles 19 E-3 pCi/ m^3 Control 22 E-3 pCi/ m^3
	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Airborne Iodine	–	All results were less than the minimal detectable concentration	All results were less than the minimal detectable concentration

Table 3.10-1 REMP Sample Results (Sheet 2 of 2)

Media	Parameter	2021 Result	2022 Result
Milk	Iodine-131	None detected	None detected
	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Food products (broadleaf vegetation)	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Grass	Gamma-emitting nuclides	No station-produced radionuclides detected	No station-produced radionuclides detected
Direct radiation	Ambient gamma radiation	Average dose per quarter for the control, inner ring, and outer ring samples were 17.4, 18.6, and 19.1 mrem, respectively	Average dose per quarter for the control, inner ring, and outer ring samples were 16.9, 18.7, and 19.0 mrem, respectively

(CEG 2023a; EGC 2021b)

Table 3.10-2 Groundwater Protection Program Results for 2021 and 2022

Media	Parameter	2021 Result	2022 Result
Groundwater	Gamma-emitting nuclides	None detected	None detected
	Strontium-89	None detected	None detected
	Strontium-90	None detected	None detected
	Gross Alpha in suspended fraction	None detected	None detected
	Gross Alpha in dissolved fraction	Detected in one sample	Detected in one sample
	Tritium	Detected in two monitoring locations 243 ± 128 pCi/L to 1,500 ± 219 pCi/L	Detected in four monitoring locations 188 ± 122 pCi/L to 383 ± 133 pCi/L
Precipitation water	Tritium	None detected	Detected in seven samples, 202 ± 121 pCi/L to 464 ± 134 pCi/L

(CEG 2023a; EGC 2021b)

3.11 Environmental Justice

This section characterizes the population and demographic characteristics, including the identification of minority and low-income individuals, within a 50-mile radius of CPS.

3.11.1 Regional Population

The GEIS presents a population characterization method based on two factors: "sparseness" and "proximity" (NRC 1996b). Sparseness measures population density and city size within 20 miles of a site and categorizes the demographic information as follows.

Demographic Categories Based on Sparseness

		Category
Most sparse	1.	Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles.
	2.	40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles.
	3.	60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles.
Least sparse	4.	Greater than or equal to 120 persons per square mile within 20 miles.

(NRC 1996b)

"Proximity" measures population density and city size within 50 miles and categorizes the demographic information as follows.

Demographic Categories Based on Proximity

		Category
Not close proximity	1.	No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles.
	2.	No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles.
	3.	One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles.
Close proximity	4.	Greater than or equal to 190 persons per square mile within 50 miles.

(NRC 1996b)

The GEIS then uses the following matrix to rank the population in the region of the station as low, medium, or high:

GEIS Sparseness and Proximity Matrix

		Proximity			
		1	**2**	**3**	**4**
Sparseness	**1**	1.1	1.2	1.3	1.4
	2	2.1	2.2	2.3	2.4
	3	3.1	3.2	3.3	3.4
	4	4.1	4.2	4.3	4.4

Low Population Area

Medium Population Area

High Population Area

(NRC 1996b)

The 2020 census population and TIGER/Line data from the USCB were used to determine demographic characteristics in the vicinity of the site (USCB 2020a). The data were processed at the state, county, and census block levels using ESRI ArcGIS software (USCB 2020d; USCB 2020f). Census data include people living in group quarters such as institutionalized and non-institutionalized populations. Examples of institutional populations living in group quarters are correctional institutions (i.e., prisons, jails, and detention centers); nursing homes; mental (psychiatric) hospitals; hospitals or wards for the chronically ill; and juvenile institutions. Examples of non-institutional populations living in group quarters are group homes; college dormitories; military quarters; soup kitchens; shelters for abused women (shelters against domestic violence or family crisis centers); and shelters for children who are runaways, neglected, or without conventional housing. (USCB 2010)

The 2020 census data indicates that approximately 60,246 people live within a 20-mile radius of the CPS site, which equates to a population density of 47.94 persons per square mile (USCB 2020f). Based on the GEIS sparseness index, the site is classified as Category 3 with at least one community with 25,000 or more persons within 20 miles.

The 2020 census data indicates that approximately 802,546 people live within a 50-mile radius of the site, which equates to a population density of 102.18 persons per square mile (USCB 2020f). Based on the GEIS proximity index, the site is classified as Category 3, with one or more cities having 100,000 or more persons and less than 190 persons per square mile within 50 miles.

As illustrated in the GEIS sparseness and proximity matrix, the combination of "sparseness" Category 3 and "proximity" Category 3 results in the conclusion that CPS is located in a "Medium" population area.

The latest permanent population projections for Illinois were obtained from the IDPH. County-level permanent population values for the counties within a 50-mile radius are shown in Table 3.11-2. Transient data for the State of Illinois was obtained from the Chicago and Illinois Leisure Visitor Profile. (IDPH 2021; IOOT 2021; MMGY 2020; USCB 2020d)

The area within a 50-mile radius of the CPS site totally or partially includes 20 counties within the state of Illinois (Table 3.11-2). According to the 2020 census, the permanent population (not including transient populations) of the entire 20 counties was 1,219,294 (Table 3.11-2). By 2047, the end of the proposed CPS operating term, the permanent population (not including transient populations) of the entire 20 counties is projected to be approximately 1,282,455. Based on 2020−2047 population projections, an annual growth rate of approximately 0.19 percent is anticipated for the permanent population in the 20 counties wholly or partially within a 50-mile radius. (IDPH 2021; IOOT 2021; MMGY 2020; USCB 2020d)

As shown in Table 3.11-2, the total population (including transient populations) of the 20 counties, which are totally or partially included within a 50-mile radius, is projected to be approximately 1,348,123 in 2047. The total population (including transient populations) within the 50-mile radius is projected to be 905,471 in 2047. (USCB 2020d; USCB 2020f; IOOT 2021; MMGY 2020)

CPS is located in DeWitt County. As shown in Table 3.11-2, the population of DeWitt County, Illinois, as reported in the 2020 Census was 15,516. Based on Illinois's population projection data, DeWitt County's projected permanent population is expected to decline. Because the county is in decline the maximum population value for the period between 2020 and 2047 was used which is 15,516, the 2020 population value. Thus, the estimated projected average annual growth rate for DeWitt County was held to zero growth (IDPH 2021; IOOT 2021; MMGY 2020; USCB 2020d).

Communities with centers falling within a 50-mile radius of CPS are listed in Table 3.11-1. As seen in Figure 3.1-3, Clinton, DeWitt, and Weldon fall within a 6-mile radius of the station. The Clinton 2020 population count was reported at 7,004 persons. The village of DeWitt had a 2020 population count of 160 and the village of Weldon had a 2020 population count of 369. (USCB 2020c).

As listed in Table 3.11-1, the largest community in DeWitt County is the city of Clinton (2020 population 7,004), located approximately 7 miles west of CPS. The city of Springfield is the only city within a 50-mile radius of CPS that has a population greater than 100,000 (114,394). A total of 7 additional communities within a 50-mile radius have populations greater than 25,000 as of 2020 (Table 3.11-1).

3.11.2 Minority and Low-Income Populations

3.11.2.1 Background

The NRC performs environmental justice analyses utilizing a 50-mile radius around the station as the environmental "impact area." LIC-203 Revision 4 defines a geographic area for comparison as a 50-mile radius (also referred to as "the region" in this discussion) centered on the nuclear plant (NRC 2020b). An alternative approach is also addressed that uses an individual state that encompasses the 50-mile radius individually for comparative analysis as the "geographic area." Both approaches were used to assess the minority and low-income population criteria for CPS.

LIC-203 guidance suggests using the most recent USCB decennial census data. However, low-income data are collected separately from the decennial census and are available in 5-year averages. The 2020 low-income and minority census population data were obtained from the USCB website and processed using ArcGIS software (USCB 2020g). Census population data were used to identify the minority and low-income populations within a 50-mile radius of CPS. Environmental justice evaluations for minority and low-income populations are based on the use of USCB block groups for minority and low-income populations.

3.11.2.2 Minority Populations

NRC procedural guidance defines a "minority" population as Black or African American, American Indian, or Alaska Native, Asian, Native Hawaiian/other Pacific Islander, some other race, two or more races, the aggregate of all minority races, Hispanic or Latino ethnicity, and the aggregate of all minority races and Hispanic ethnicity (NRC 2020b). The guidance indicates that a minority population is considered present if either of the following two conditions exists:

1. The minority population in the census block group exceeds 50 percent; or
2. The minority population percentage is more than 20 percent greater in the census block group than the minority percentage of the geographic area chosen for the comparative analysis.

To establish minimum thresholds for each minority category, the non-white minority population total for the state of Illinois was divided by the total population of the state. This process was repeated with a 50-mile radius total minority population and 50-mile radius total population. As described in the second criterion, 20 percent was added to the minority percentage values for each geographic area. The lower of the two NRC conditions for a minority population was selected as defining a minority area (i.e., census block group minority population exceeds 50 percent, or minority population is more than 20 percent greater than the minority population of the geographic area). Any census block group with a percentage exceeding this value was considered a minority population. Minority percentages for Illinois, a 50-mile radius, and the corresponding criteria, are shown in Table 3.11-3.

A minority category of "Aggregate of All Races" is created when the populations of all the 2020 USCB minority categories are summed. As shown in Table 3.11-3, the 2020 "Aggregate of All

Races" category, when compared to the total population, indicates 21.7 percent of the population in a 50-mile radius (region) are minorities. The "Aggregate of All Races" population percentages for Illinois is 38.6. None of the percentages exceeded the 50 percent noted for Condition 1, defined above. As such, the criteria calculated using Condition 2 listed in Table 3.11-3 was used for the threshold. Using the alternate approach defined above, where a 50-mile radius is used as the geographic area, any census block group with a combined "Aggregate of All Races" population equal to or greater than 41.7 percent would be considered a minority population. Similarly, the state was evaluated and a series of criteria for each race and low-income category were defined. When the state is used as the geographic area, any census block group with an "Aggregate of All Races" population exceeding 50.0 percent in Illinois was considered a minority population. (USCB 2020d; USCB 2020g)

Because Hispanic is not considered a race by the USCB, Hispanics are already represented in the census-defined race categories. However, because Hispanics can be represented in any race category, some white Hispanics not otherwise considered minorities become classified as a minority when categorized in the "Aggregate and Hispanic" category.

The number of census block groups contributing to the minority population count were evaluated using the criteria shown in Table 3.11-3 and summarized in Table 3.11-4. The results of the evaluation are census block groups flagged as having a minority population(s). The resulting maps (Figures 3.11-1, 3.11-2, 3.11-3, 3.11-4, 3.11-5, 3.11-6, 3.11-7, 3.11-8, 3.11-9, 3.11-10, 3.11-11 and 3.11-12) depict the location of minority population census block groups flagged accordingly for each race or aggregate category. Because no block group met the criteria for the "American Indian and Alaskan Native", the "Native Hawaiian/Other Pacific Islander" or the "Two or More Races" race categories, no figures illustrating those race categories were produced. The identified minority population block groups are associated with communities or USCB defined areas. (USCB 2020a; USCB 2020ag)

The percentage of census block groups exceeding the "Aggregate of All Races" minority population criterion was 17.4 percent when a 50-mile radius (region) was used and 12.8 percent when the individual state was used as the geographic area (Table 3.11-4). For the "Aggregate and Hispanic" category, 18.3 percent of the census block groups contained a minority population when the region was used, and 14.3 percent of the block groups contained minority populations when the individual state was used (Table 3.11-4). The minority population values of the block groups were reduced when races were analyzed individually. (USCB 2020a; USCB 2020g)

The identified minority population closest to CPS is located approximately 18.4 miles north-northwest of the power station (Block Group 171130021014). This census block group contained a total of 1,573 persons. Using the regional criteria, the block group contains a Some Other Race population and a Hispanic or Latino population. Using the state criteria this census block group did not contain a minority population. (USCB 2020g)

There is an additional identified minority block group within the CPS vicinity at approximately 19.6 miles south-southwest of the site (Block Group 171150022001). This census block group contained a total of 1,232 people. Using either the individual state criteria or the regional criteria, the block group contains the following minority populations: Black or African American, Aggregate of all Races, and Aggregate and Hispanic. (USCB 2020g)

As presented in Section 3.1.3, there are no federal or state recognized native American Indian tribes with reservations or identified lands located in the 50-mile region.

3.11.2.3 Low-Income Populations

NRC guidance defines "low-income" using USCB statistical poverty thresholds for individuals or families (NRC 2020b). As addressed above with minority populations, the state of Illinois and the 50-mile region were used as the geographic area for comparison in this analysis. The guidance indicates that a low-income population is considered present if either of the two following conditions exists:

1. The low-income population in the census block group exceeds 50 percent; or
2. The percentage of households below the poverty level in a block group is significantly greater (typically at least 20 percent) than the low-income population percentage of the geographic area chosen for the comparative analysis (i.e., individual state and region's combined average).

To establish minimum thresholds for the individual low-income category, the population with an income below the poverty level for the state was divided by the total population for whom poverty status is determined in the state. To establish minimum thresholds for the family low-income category, the family population count with an income below the poverty level for the state was divided by the total family population count in the state. This process was repeated for the regional population with an income below the poverty level and regional total population for whom poverty status is determined. As described in Condition 2, above, 20 percent was added to the low-income values for individuals and families and each geographic area.

As shown in Table 3.11-5, when the 2016–2020 census data category "income in the past 12 months below poverty level" (individual) is compared to "total population for whom poverty status is determined," 14.2 percent of the population in the region has an individual income below poverty level. In Illinois, the percentage of individuals with an income below poverty level is 12.0. (USCB 2020g)

As shown in Table 3.11-5, Illinois has an estimated 585,619 families living below poverty level When the 2016–2020 census data family category "income in the past 12 months below poverty level" is compared to "total family count," 14.2 percent of the families within the region has an income below poverty level. In Illinois, the percentage of the family population with an income below poverty level is 12.0 percent. (USCB 2020g)

As an example of calculating the criteria, when the region is used as the geographic area, any census block group within a 50-mile radius with populations of low-income individuals equal to or greater than 34.2 (14.2 + 20) percent of the total block group population would be considered a "low-income population." Using this criterion, 97 of the 726 census block groups (13.4) percent were identified as low-income populations within a 50-mile radius of the CPS site, as shown in Figure 3.11-13. (USCB 2020a; USCB 2020g)

When Illinois is used as the geographic area, any census block group within the Illinois portion of the region with a low-income (individual) population equal to or greater than 32 percent of the total block group, the population would be considered a "low-income population" (individual) (Table 3.11-5). Using this criterion, 106 of the total 726 census block groups (14.6) percent have low-income individual population percentages that meet or exceed the threshold criteria noted in Table 3.11-6. These census block groups are illustrated in Figure 3.11-14.

Similarly, these criteria are calculated using both geographic areas and family census counts (Table 3.11-6). Using the family individual state criteria, 81 census block groups were identified as having low-income families. Using the family regional criteria, 77 census block groups were identified as having low-income families (Table 3.11-6). These census block groups are illustrated in Figures 3.11-15 and 3.11-16. (USCB 2020g) The closest low-income block group that meets the guidance criteria for individuals or families is located approximately 19.2 miles south-southwest of the CPS center point (Block Group 171150029021). (USCB 2020g)

3.11.3 Subsistence Populations and Migrant Workers

3.11.3.1 Subsistence Populations

Subsistence refers to the use of natural resources as food for consumption and for ceremonial and traditional cultural purposes, usually by low-income or minority populations. Specific examples of subsistence use include gathering plants for direct consumption (rather than produced for sale from farming operations), for use as medicine, or in ritual practices. Fishing or hunting activities associated with direct consumption or use in ceremonies, rather than for sport, are other examples.

Determining the presence of subsistence use can be difficult, as data at the county or block group level are aggregated and not usually structured to identify such uses on or near the site. Frequently, the best means of investigating the presence of subsistence use is through dialogue with the local population who are most likely to know of such activity. Interviews conducted with local CPS staff included possible knowledge of subsistence activity.

The area surrounding CPS is largely agricultural. Over 88 percent of land in DeWitt County is allocated to agricultural, 3 percent as Ag-Residential, and 0.1 percent as Commercial Agriculture (DC 2018). CPS staff were interviewed to identify whether there are any subpopulations near CPS (DeWitt County) that engage in a subsistence-like lifestyle. This would include groups in which hunting, gathering, fishing, and gardening constituted a substantially larger fraction of the subpopulation's food sources than those of the general population. No known subsistence-based activity was identified in the CPS vicinity.

However, Amish communities are located throughout the State of Illinois. The city of Arthur is the heart of the Illinois Amish community and home to the largest and oldest Amish community in the state (AA 2022). The city of Arthurs' Amish community is located approximately 37 miles south-southeast of CPS and may engage in a subsistence-like lifestyle.

Each year a REMP land use census is conducted to assess the contribution of radionuclides to the environment resulting from CPS operation. The census is conducted by traveling all roads within a 5-mile radius of the station site and recording and mapping the locations of the nearest resident, available milk animal, and vegetable garden. The results for each sample type are discussed in the publicly available annual ARERRs and compared to historical data to determine if there are any observable trends. No values have exceeded the limits set by the NRC. As such, the REMP program has not identified any significant effects to the environment, therefore no potential impact pathways that would have an effect on the Amish population were identified.

3.11.3.2 Migrant Workers

Migrant labor, or a migrant worker, is defined by the USDA as "a farm worker whose employment required travel that prevented the migrant worker from returning to his/her permanent place of residence the same day." In 2017, DeWitt County reported that 143 out of 504 total farms employed farm labor. An estimated total of 305 farm laborers were hired, of which 227 were estimated to work fewer than 150 days per year (USDA 2017).

Table 3.11-1 Cities, CDPs, and Villages Located Totally or Partially Within a 50-Mile Radius of CPS (Sheet 1 of 5)

City/Borough/ Village/CDP	County	2010 Census Population[(a)]	2020 Census Population[(a)]	Distance to CPS (Miles)[(b)(c)]	Direction [(b)(c)]
Allenville	Moultrie	148	132	46	SSE
Anchor	McLean	146	163	32	NNE
Arcola	Douglas	2,916	2,927	44	SE
Argenta	Macon	947	913	13	S
Armington	Tazewell	343	310	28	WNW
Arrowsmith	McLean	294	276	22	NNE
Arthur	Douglas	2,288	2,231	37	SSE
Assumption	Christian	1,168	1,155	46	SSW
Athens	Menard	1,988	1,977	49	WSW
Atlanta	Logan	1,692	1,669	22	WNW
Atwood	Douglas	1,224	1,116	32	SE
Bellflower	McLean	357	346	20	NE
Bement	Piatt	1,730	1,484	22	SE
Benson	Woodford	423	412	49	NNW
Bethany	Moultrie	1,352	1,255	37	S
Bloomington	McLean	76,610	78,680	23	NNW
Blue Mound	Macon	1,158	1,133	36	SSW
Bondville	Champaign	443	388	25	E
Broadlands	Champaign	349	316	48	ESE
Broadwell	Logan	145	136	33	W
Buffalo	Sangamon	503	447	38	SW
Camargo	Douglas	445	452	44	SE
Cantrall	Sangamon	139	144	47	WSW
Carlock	McLean	552	548	32	NNW
Cerro Gordo	Piatt	1,403	1,316	20	SSE
Champaign	Champaign	81,055	88,302	32	E
Chatsworth	Livingston	1,205	1,185	49	NE
Chenoa	McLean	1,785	1,720	40	N
Cisco	Piatt	261	254	13	SSE
Clear Lake	Sangamon	229	203	46	WSW
Clinton	DeWitt	7,225	7,004	7	W

Table 3.11-1 Cities, CDPs, and Villages Located Totally or Partially Within a 50-Mile Radius of CPS (Sheet 2 of 5)

City/Borough/ Village/CDP	County	2010 Census Population[(a)]	2020 Census Population[(a)]	Distance to CPS (Miles)[(b)(c)]	Direction [(b)(c)]
Colfax	McLean	1,061	996	30	NNE
Congerville	Woodford	474	497	36	NNW
Cooksville	McLean	182	157	26	NNE
Dalton City	Moultrie	544	454	32	S
Danvers	McLean	1,154	1,089	31	NW
Dawson	Sangamon	509	519	40	WSW
De Land	Piatt	446	447	11	ESE
DeWitt	DeWitt	184	160	3	ENE
Decatur	Macon	76,122	70,522	24	SSW
Deer Creek	Tazewell	704	667	41	NW
Delavan	Tazewell	1,689	1,568	40	WNW
Downs	McLean	1,005	1,201	16	N
East Peoria	Tazewell	23,402	22,484	52	NW
Edinburg	Christian	1,078	1,085	46	SW
El Paso	Woodford	2,810	2,756	40	NNW
Elkhart	Logan	405	450	36	WSW
Elliott	Ford	295	274	36	ENE
Ellsworth	McLean	195	184	20	NNE
Emden	Logan	485	467	35	WNW
Eureka	Woodford	5,295	5,227	44	NNW
Fairbury	Livingston	3,757	3,633	43	NNE
Farmer City	DeWitt	2,037	1,828	11	ENE
Findlay	Shelby	683	664	45	S
Fisher	Champaign	1,881	2,062	27	ENE
Flanagan	Livingston	1,110	1,010	49	N
Foosland	Champaign	101	75	25	ENE
Forrest	Livingston	1,220	1,041	46	NNE
Forsyth	Macon	3,490	3,734	18	SSW
Garrett	Douglas	162	122	34	SE
Gibson City	Ford	3,407	3,475	31	NE
Gifford	Champaign	975	911	44	E

Table 3.11-1 Cities, CDPs, and Villages Located Totally or Partially Within a 50-Mile Radius of CPS (Sheet 3 of 5)

City/Borough/ Village/CDP	County	2010 Census Population[(a)]	2020 Census Population[(a)]	Distance to CPS (Miles)[(b)(c)]	Direction [(b)(c)]
Goodfield	Woodford	860	936	39	NW
Grandview	Sangamon	1,441	1,405	48	WSW
Green Valley	Tazewell	709	630	46	WNW
Greenview	Menard	778	745	48	W
Gridley	McLean	1,432	1,456	39	N
Hammond	Piatt	509	508	29	SSE
Harristown	Macon	1,367	1,310	26	SSW
Hartsburg	Logan	314	262	32	W
Heyworth	McLean	2,841	2,791	12	NW
Hindsboro	Douglas	313	275	50	SE
Homer	Champaign	1,193	1,073	47	ESE
Hopedale	Tazewell	865	830	35	WNW
Hudson	McLean	1,838	1,753	31	NNW
Humboldt	Coles	437	361	48	SE
Illiopolis	Sangamon	891	846	31	SW
Ivesdale	Champaign	267	265	26	SE
Kappa	Woodford	227	229	36	NNW
Kenney	DeWitt	326	311	14	WSW
Latham	Logan	380	333	22	SW
Le Roy	McLean	3,560	3,512	13	NNE
Lexington	McLean	2,060	2,090	32	N
Lincoln	Logan	14,504	13,288	28	W
Loda	Iroquois	407	356	47	ENE
Long Creek	Macon	1,328	1,261	25	S
Longview	Champaign	153	112	45	ESE
Lovington	Moultrie	1,130	1,069	33	SSE
Ludlow	Champaign	371	308	40	ENE
Mackinaw	Tazewell	1,950	1,879	37	NW
Macon	Macon	1,138	1,177	33	SSW
Mahomet	Champaign	7,258	9,434	23	E
Mansfield	Piatt	906	928	18	E

Table 3.11-1 Cities, CDPs, and Villages Located Totally or Partially Within a 50-Mile Radius of CPS (Sheet 4 of 5)

City/Borough/ Village/CDP	County	2010 Census Population[a]	2020 Census Population[a]	Distance to CPS (Miles)[b][c]	Direction [b][c]
Maroa	Macon	1,801	1,577	11	SW
Mason City	Mason	2,343	2,077	46	W
McLean	McLean	830	743	20	WNW
Mechanicsburg	Sangamon	590	662	39	SW
Melvin	Ford	452	416	41	NE
Middletown	Logan	324	329	40	W
Minier	Tazewell	1,252	1,154	31	NW
Monticello	Piatt	5,548	5,941	17	SE
Morton	Tazewell	16,267	17,117	45	NW
Mount Auburn	Christian	480	452	36	SW
Mount Pulaski	Logan	1,566	1,537	26	WSW
Mount Zion	Macon	5,833	6,019	28	S
Moweaqua	Shelby	1,831	1,764	39	SSW
New Holland	Logan	269	275	39	W
Niantic	Macon	707	612	28	SW
Normal	McLean	52,497	52,736	25	NNW
Ogden	Champaign	810	729	47	E
Oreana	Macon	875	891	16	S
Panola	Woodford	45	47	43	NNW
Paxton	Ford	4,473	4,450	44	ENE
Pekin	Tazewell	34,094	31,731	51	NW
Pesotum	Champaign	551	550	35	ESE
Philo	Champaign	1,466	1,392	38	ESE
Pontiac	Livingston	11,931	11,150	50	NNE
Rantoul	Champaign	12,941	12,371	37	ENE
Riverton	Sangamon	3,455	3,532	44	WSW
Roanoke	Woodford	2,065	1,960	47	NNW
Roberts	Ford	362	345	46	NE
Rochester	Sangamon	3,689	3,863	47	SW
Royal	Champaign	293	293	46	E
Sadorus	Champaign	416	402	30	ESE

Table 3.11-1 Cities, CDPs, and Villages Located Totally or Partially Within a 50-Mile Radius of CPS (Sheet 5 of 5)

City/Borough/ Village/CDP	County	2010 Census Population[(a)]	2020 Census Population[(a)]	Distance to CPS (Miles)[(b)(c)]	Direction [(b)(c)]
San Jose	Logan	642	479	42	WNW
Savoy	Champaign	7,280	8,857	32	ESE
Saybrook	McLean	693	654	24	NE
Secor	Woodford	373	342	42	NNW
Sherman	Sangamon	4,148	4,673	45	WSW
Sibley	Ford	272	288	37	NE
Sidney	Champaign	1,233	1,208	42	ESE
South Pekin	Tazewell	1,146	996	49	WNW
Spaulding	Sangamon	873	801	43	WSW
Springfield	Sangamon	116,250	114,394	50	WSW
St. Joseph	Champaign	3,967	3,810	42	E
Stanford	McLean	596	600	27	NW
Stonington	Christian	932	837	41	SSW
Strawn	Livingston	100	101	40	NE
Sullivan	Moultrie	4,440	4,413	41	SSE
Taylorville	Christian	11,246	10,506	49	SSW
Thomasboro	Champaign	1,126	1,034	35	E
Tolono	Champaign	3,447	3,604	33	ESE
Towanda	McLean	480	431	27	N
Tremont	Tazewell	2,236	2,277	42	NW
Tuscola	Douglas	4,480	4,636	39	SE
Urbana	Champaign	41,250	38,336	34	E
Villa Grove	Douglas	2,537	2,472	42	ESE
Wapella	DeWitt	558	513	7	WNW
Warrensburg	Macon	1,210	1,110	20	SW
Washington	Tazewell	15,134	16,071	47	NW
Waynesville	DeWitt	434	381	16	WNW
Weldon	DeWitt	429	369	6	SE
Williamsville	Sangamon	1,476	1,425	41	WSW

a. (USCB 2020c)
b. (USCB 2020a; USDOT 2022a)
c. Distances reported were measured from the CPS center point to the city center.

Table 3.11-2 County Populations Totally or Partially Within a 50-Mile Radius of CPS

State, County, and Independent City	2010 Population[(a)]	2020 Population[(a)]	2047 Projected Permanent Population[(a,b)]	2047 Projected Total Population[(a,b,c)]
Illinois (20 counties)	**1,254,146**	**1,219,294**	**1,282,455**	**1,348,123**
Champaign	201,081	205,865	224,582	236,082
Christian	34,800	34,032	34,032	35,775
Coles	53,873	46,863	48,633	51,124
DeWitt	16,561	15,516	15,516	16,310
Douglas	19,980	19,740	19,740	20,751
Ford	14,081	13,534	13,534	14,227
Iroquois	29,718	27,077	27,077	28,463
Livingston	38,950	35,815	35,815	37,649
Logan	30,305	27,987	27,987	29,420
Macon	110,768	103,998	103,998	109,323
Mason	14,666	13,086	13,086	13,756
McLean	169,572	170,954	208,914	219,611
Menard	12,705	12,297	12,356	12,989
Moultrie	14,846	14,526	14,526	15,270
Piatt	16,729	16,673	16,673	17,527
Sangamon	197,465	196,343	197,295	207,397
Shelby	22,363	20,990	20,990	22,065
Tazewell	135,394	131,343	131,390	138,118
Vermilion	81,625	74,188	74,188	77,987
Woodford	38,664	38,467	42,122	44,279

a. (USCB 2020d)
b. (IDPH 2019)
c. (IOOT 2021; MMGY 2020)

Table 3.11-3 Minority Populations Evaluated Against Criterion

Geographic Area	Illinois[a]			50-Mile Radius (Region)[b]		
Total Population	12,812,508			867,941		
Census Categories	State Population by Census Category[a]	Percent[c]	Criteria	Regional Population by Census Category[b]	Percent[c]	Criteria
Black or African American	1,808,271	14.1	34.1	81,322	9.4	29.4
American Indian or Alaska Native	96,498	0.8	20.8	2,379	0.3	20.3
Asian	754,878	5.9	25.9	36,909	4.3	24.3
Native Hawaiian/Other Pacific Islander	4,501	0.04	20.0	295	0.03	20.0
Some Other Race	1,135,149	8.9	28.9	18,113	2.1	22.1
Two or More Races	1,144,984	8.9	28.9	49,219	5.7	25.7
Aggregate of All Races	4,944,281	38.6	50.0	188,237	21.7	41.7
Hispanic or Latino	2,337,410	18.2	38.2	41,215	4.7	24.7
Aggregate and Hispanic[d]	5,339,757	41.7	50.0	198,925	22.9	42.9

a. (USCB 2020d)
b. (USCB 2020g)
c. Percent values were calculated by dividing each Census Categories' population by the state or region total population values.
d. Includes everyone except persons who identified themselves as White, Not Hispanic or Latino (NRC 2020b).

Table 3.11-4 Minority Census Block Group Counts, 50-Mile Radius of CPS

Total Number of Block Groups with Population within 50-mile radius	Individual State Method		50-Mile Radius (Region)	
	726		726	
Census Categories	Number of Block Groups with Identified Minority and Low-Income Category	Percent of Block Groups within 50 miles	Number of Block Groups with Identified Minority and Low-Income Category	Percent of Block Groups within 50 miles
Black or African American	74	10.2	90	12.4
American Indian or Alaska Native	0	0	0	0
Asian	21	2.9	23	3.2
Native Hawaiian/Other Pacific Islander	0	0	0	0
Some Other Race	2	0.3	5	0.7
Two or More Races	0	0	0	0
Aggregate of All Races	93	12.8	126	17.4
Hispanic or Latino	3	0.4	10	1.4
Aggregate and Hispanic	104	14.3	133	18.3

(USCB 2020a; USCB 2020g)

Table 3.11-5 Low-Income Population Criteria Using Two Geographic Areas

(Income) Total Population	Illinois[a]			50-Mile Radius (Region)[b]		
	12,418,504			834,527		
(Income) Total Families	4,884,061			350,910		
Census Category	State Population by Census Category	Percent[c]	Criteria	State Population by Census Category	Percent[c]	Criteria
Low Income – Number of Persons Below Poverty Level (Individuals)	1,488,670	12.0	32.0	118,512	14.2	34.2
Low Income – Number of Families Below Poverty Level (Households)	585,619	12.0	32.0	49,747	14.2	34.2

a. (USCB 2020d)

b. (USCB 2020g)

c. Percent values were calculated by dividing each Census Categories' population by the state and regional total population values.

Table 3.11-6 Low-Income Census Block Group Counts, 50-Mile Radius of CPS

Total Number of Block Groups with Population within 50-mile radius	Individual State Method		50-Mile Radius (Region)	
	Census Block Groups		Census Block Groups	
	726		726	
Census Categories	Number of Block Groups with Identified Minority and Low-Income Category	Percent of Block Groups within 50 miles	Number of Block Groups with Identified Minority and Low-Income Category	Percent of Block Groups within 50 miles
Low Income Individuals	106	14.6	97	13.4
Low Income Families (Households)	81	11.2	77	10.6

(USCB 2020a; USCB 2020g)

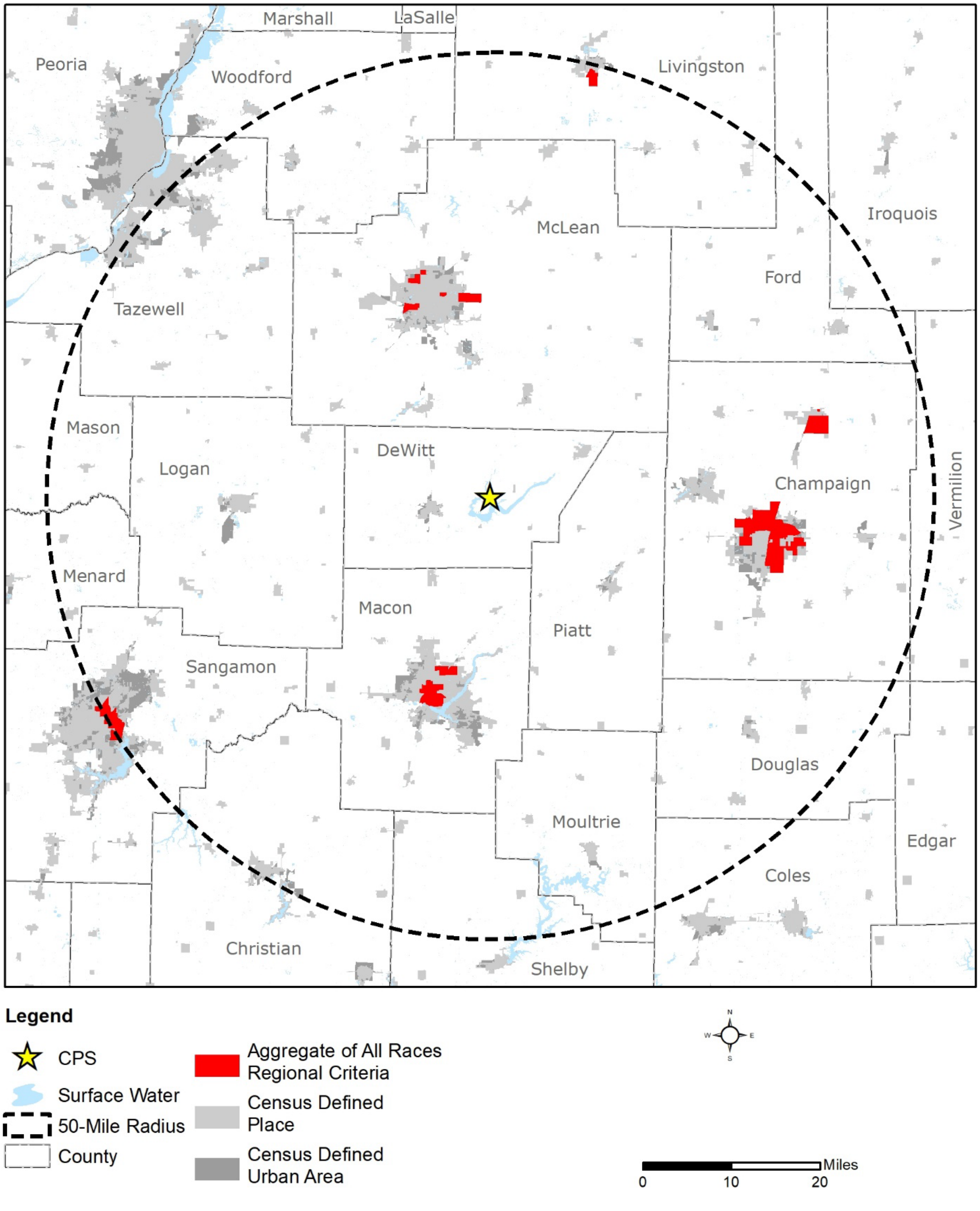


Figure 3.11-1 Aggregate of All Races Populations (Regional)

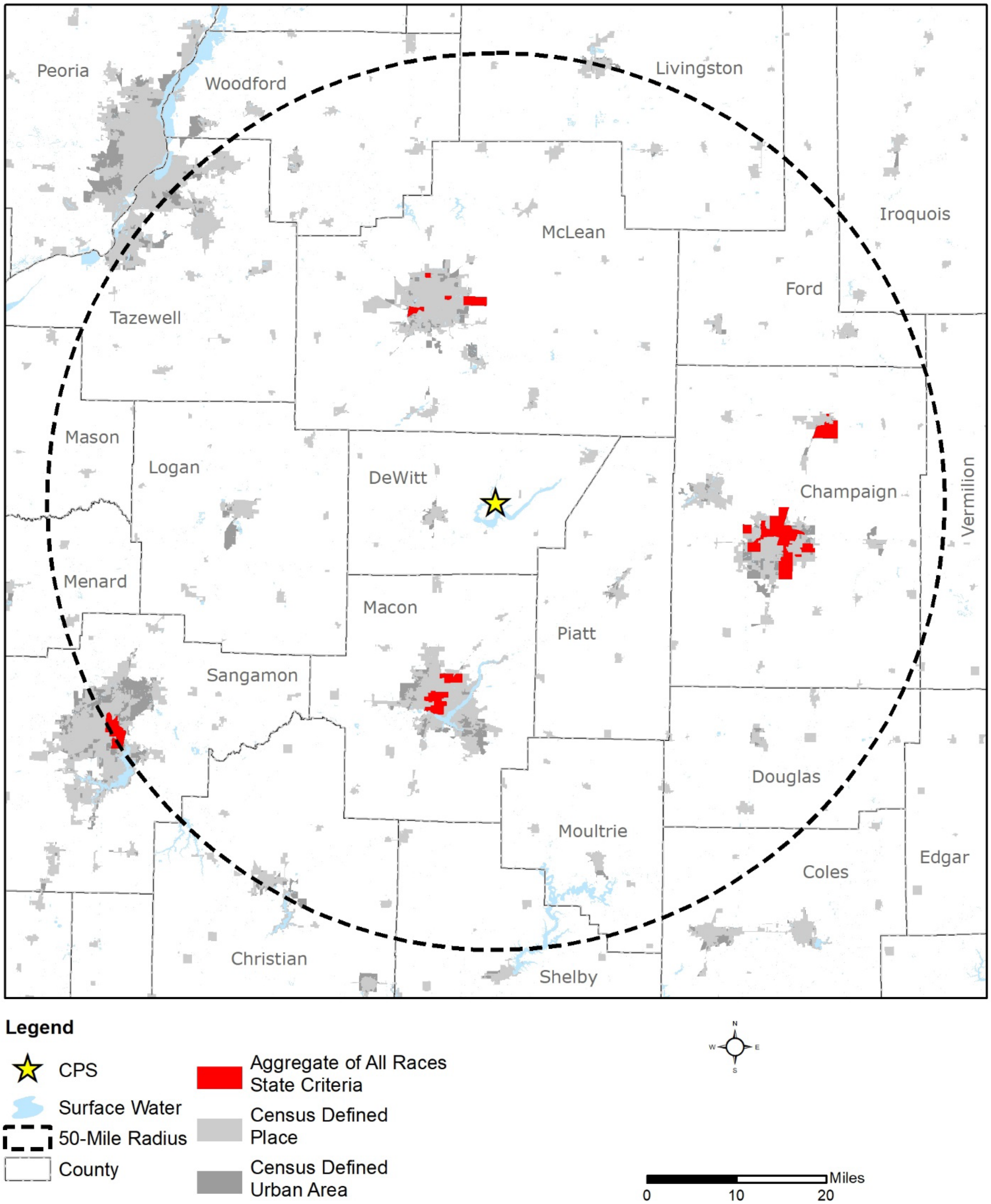


Figure 3.11-2 Aggregate of All Races Populations (Individual State)

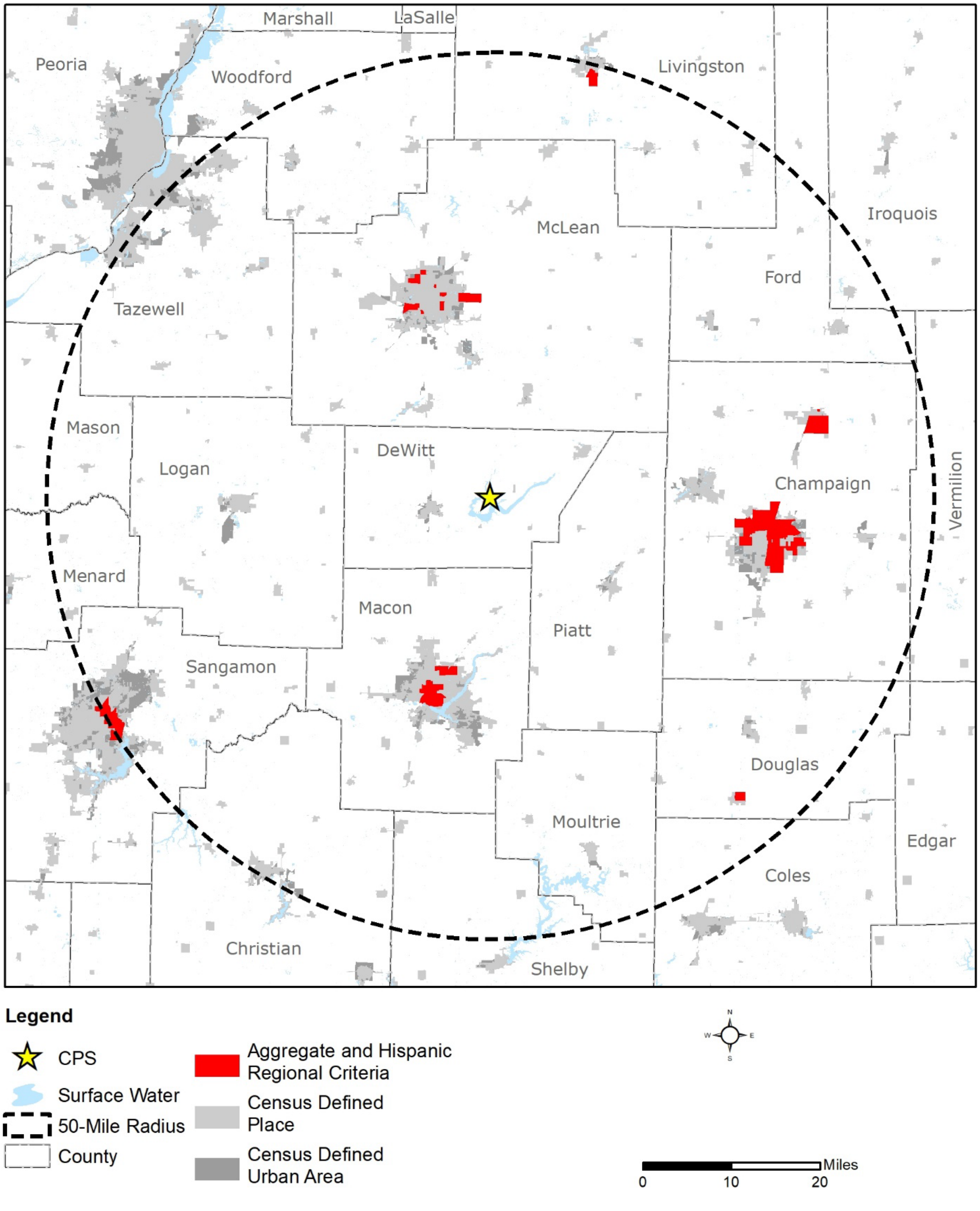


Figure 3.11-3 Aggregate and Hispanic Populations (Regional)

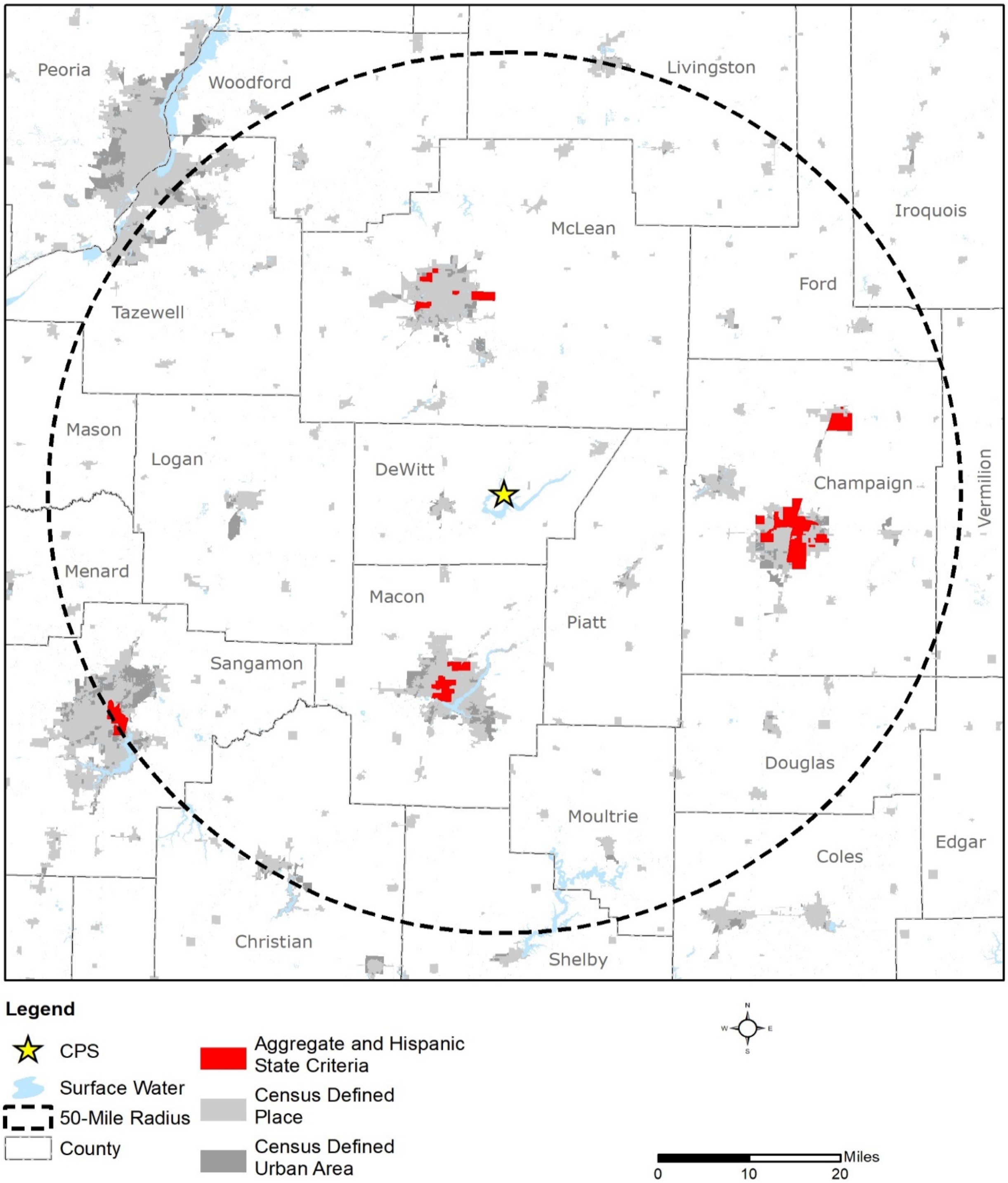


Figure 3.11-4 Aggregate and Hispanic Populations (Individual State)

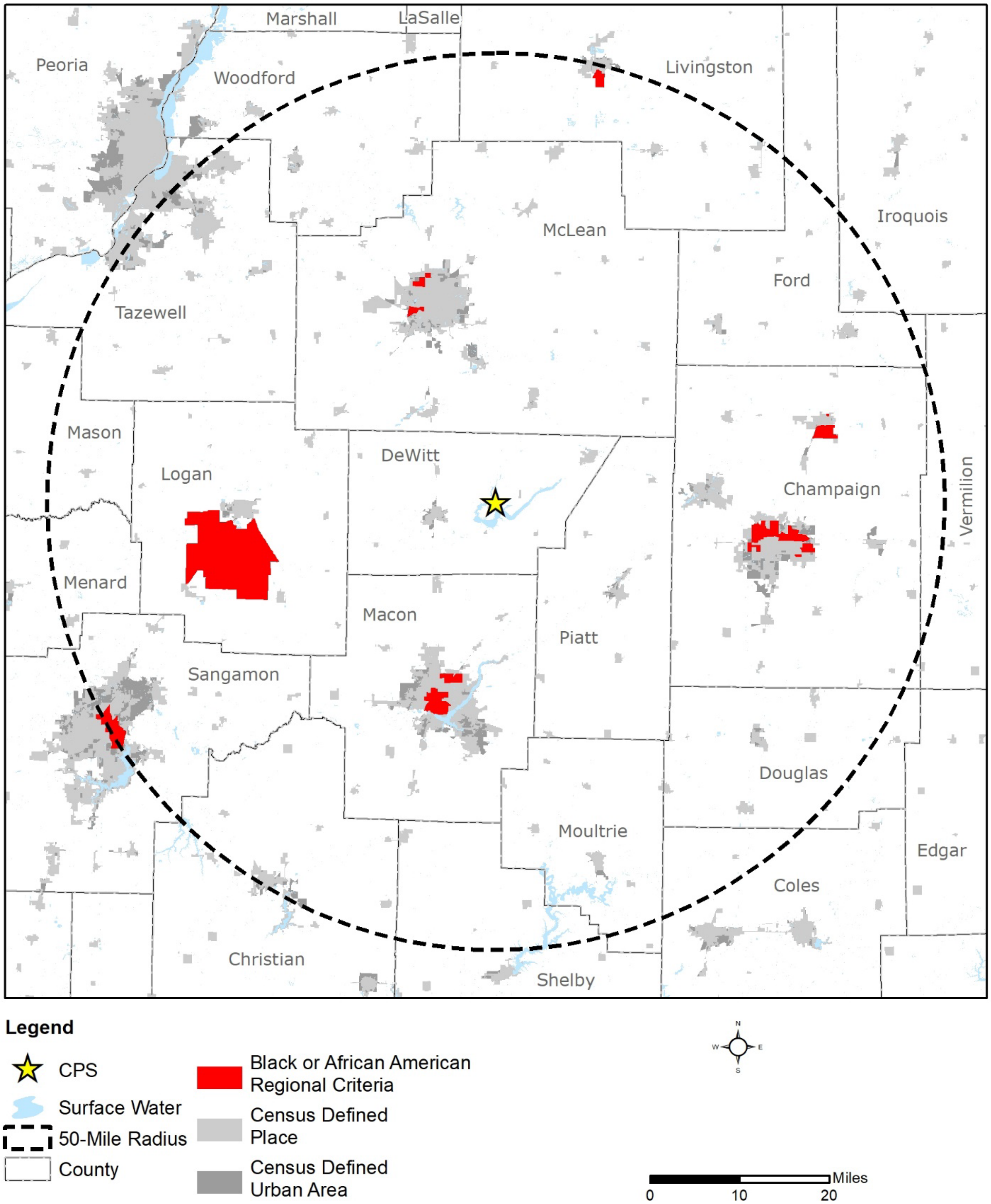


Figure 3.11-5 Black or African American Populations (Regional)

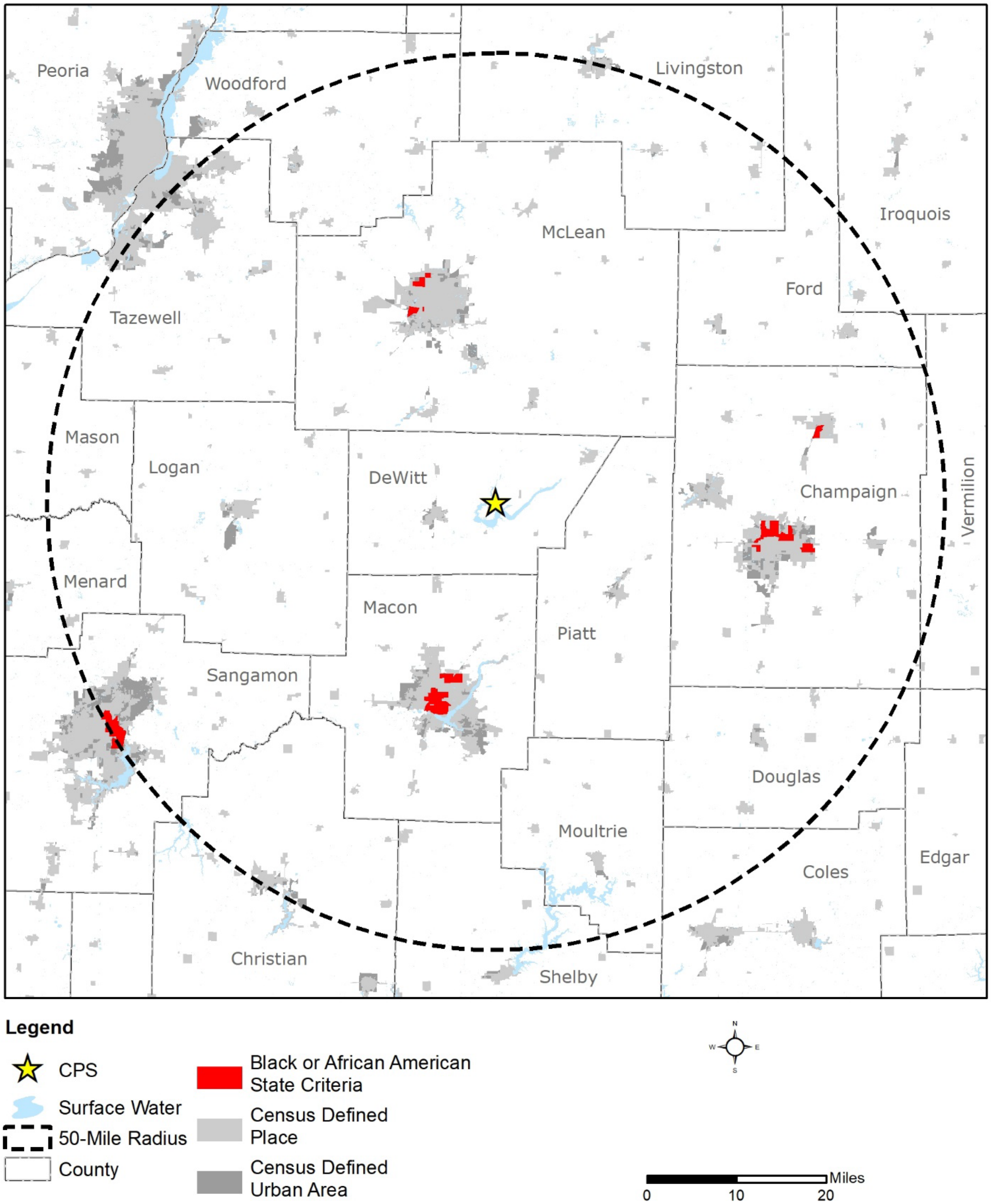


Figure 3.11-6 Black or African American Populations (Individual State)

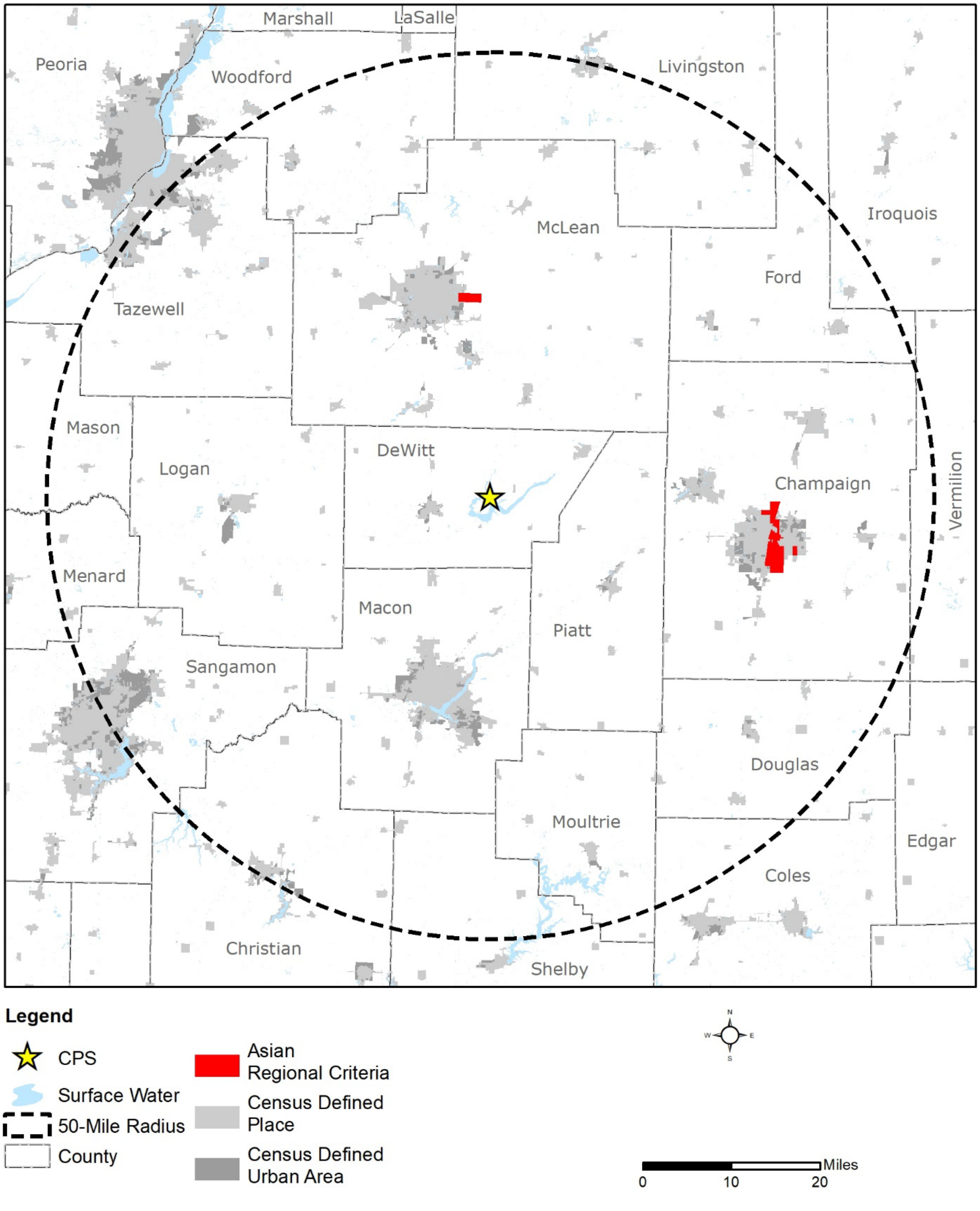


Figure 3.11-7 Asian Populations (Regional)

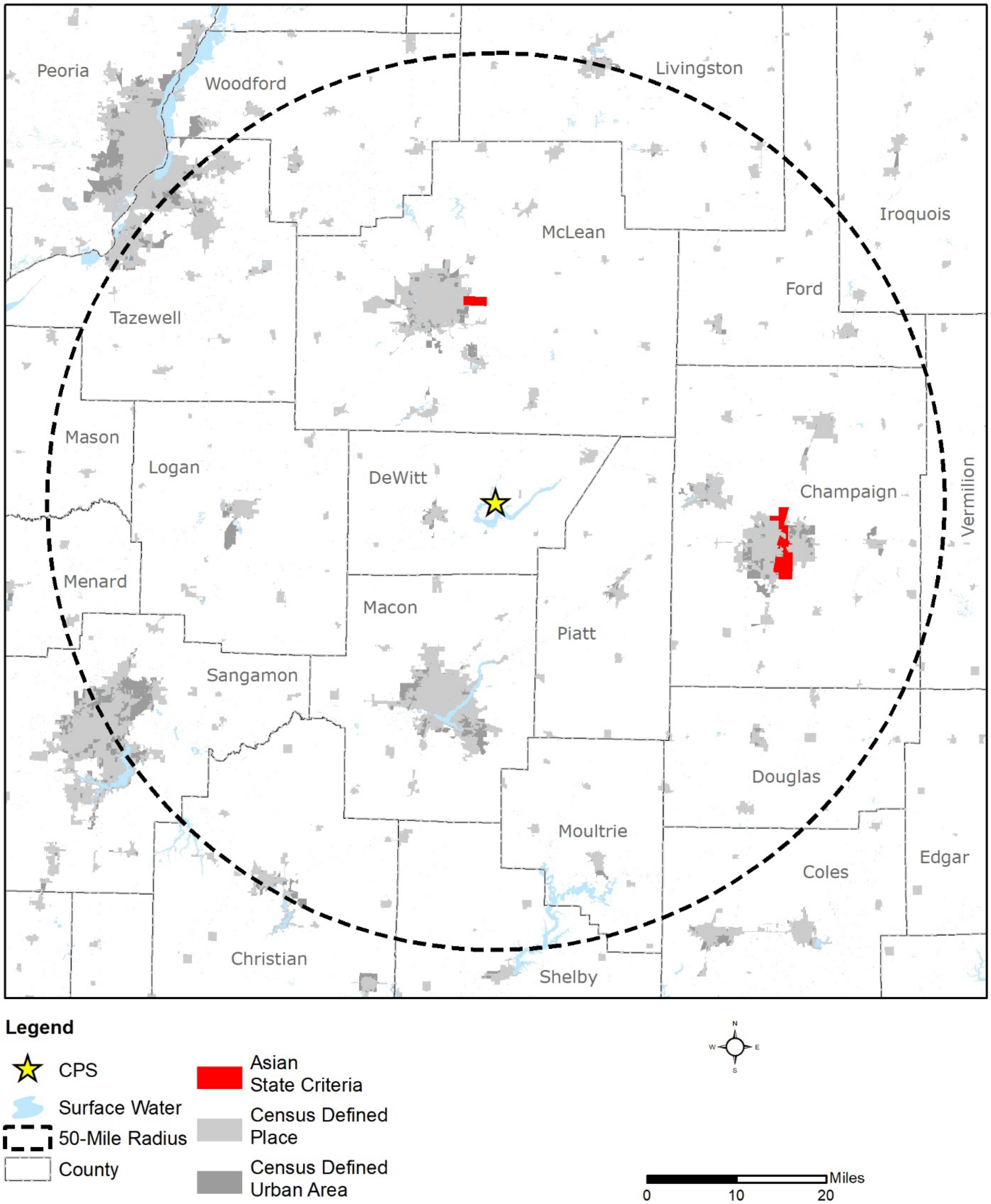


Figure 3.11-8 Asian Populations (Individual State)

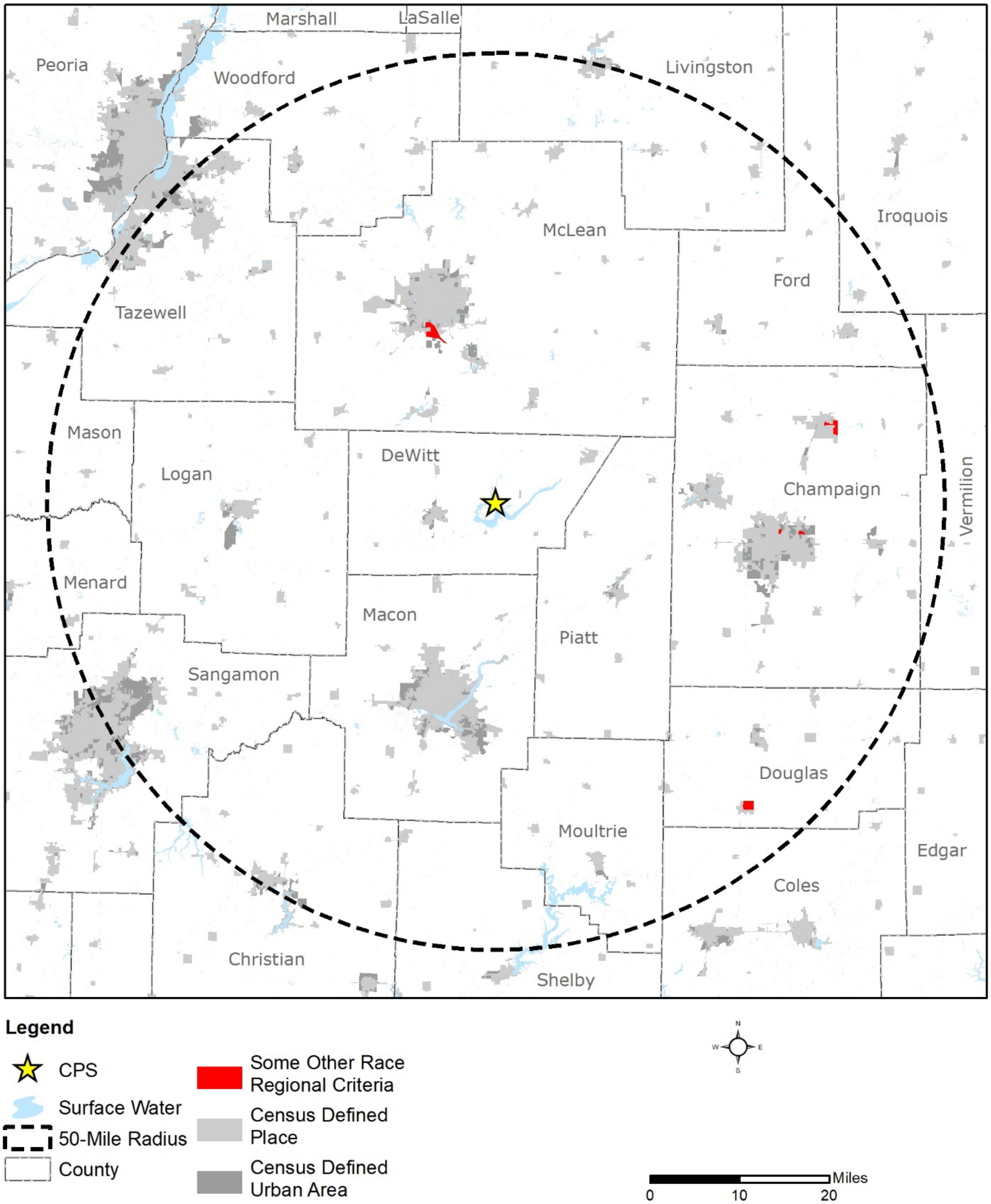


Figure 3.11-9 Some Other Race Populations (Regional)

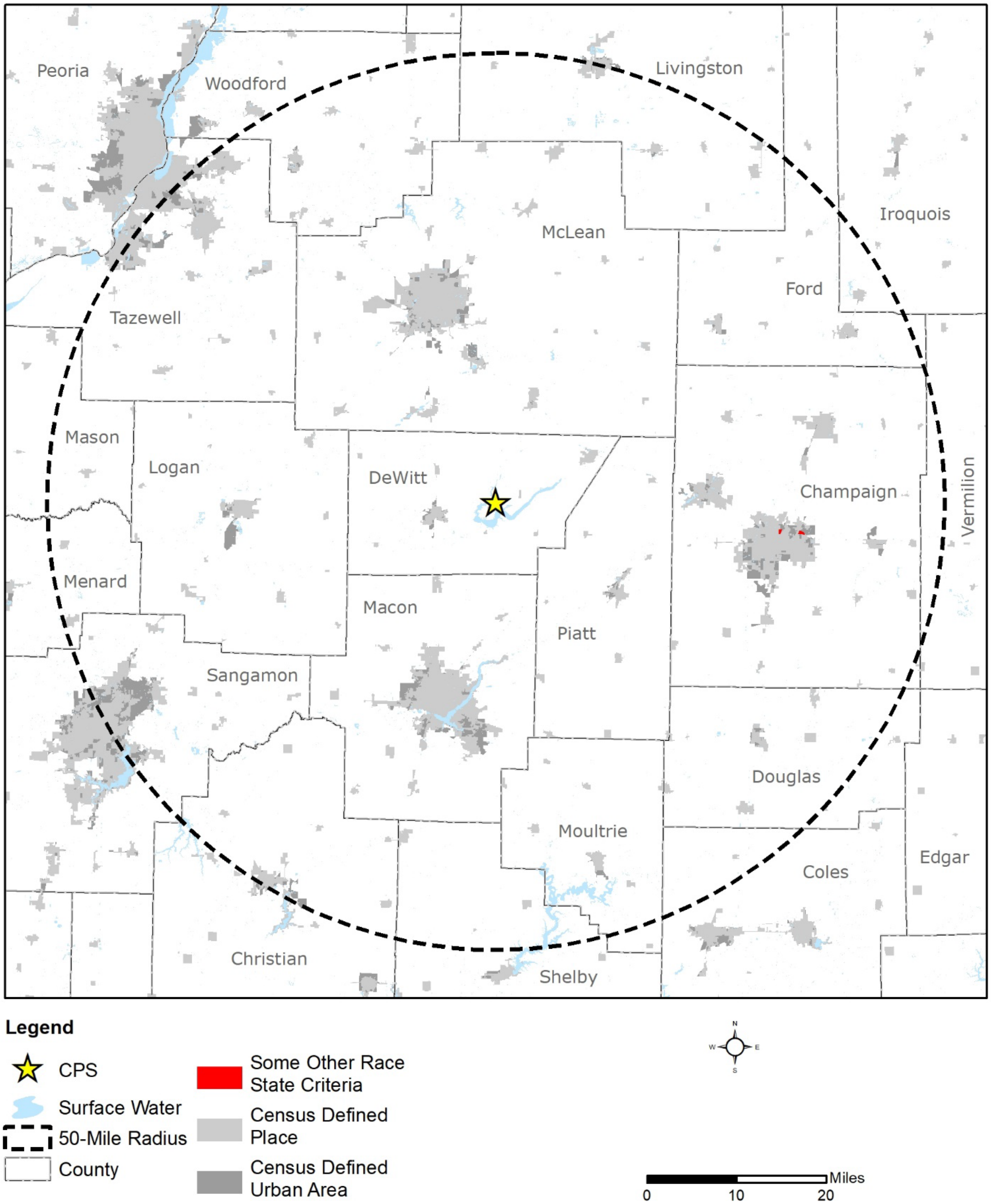


Figure 3.11-10 Some Other Race Populations (Individual State)

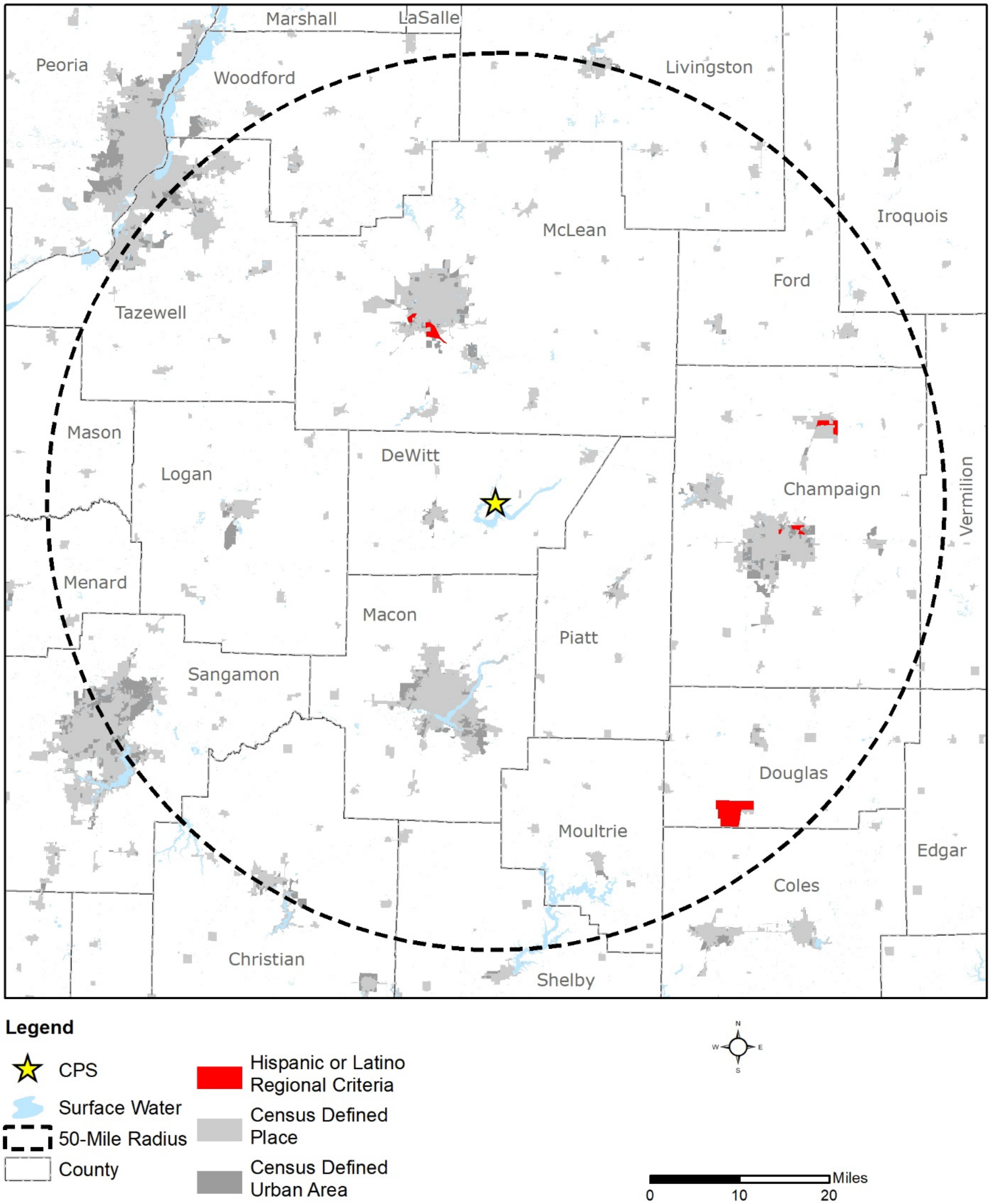


Figure 3.11-11 Hispanic or Latino Populations (Regional)

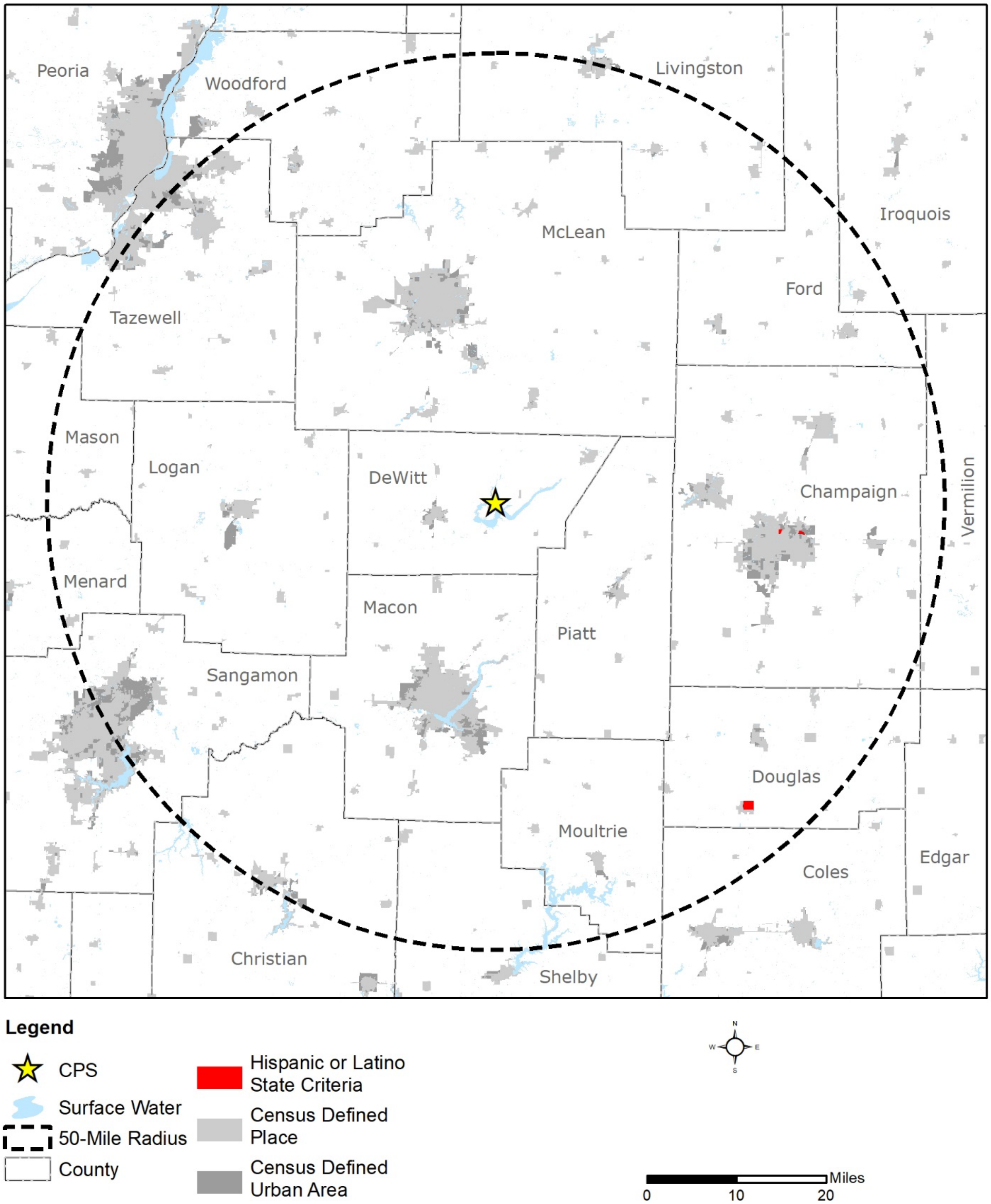


Figure 3.11-12 Hispanic or Latino Populations (Individual State)

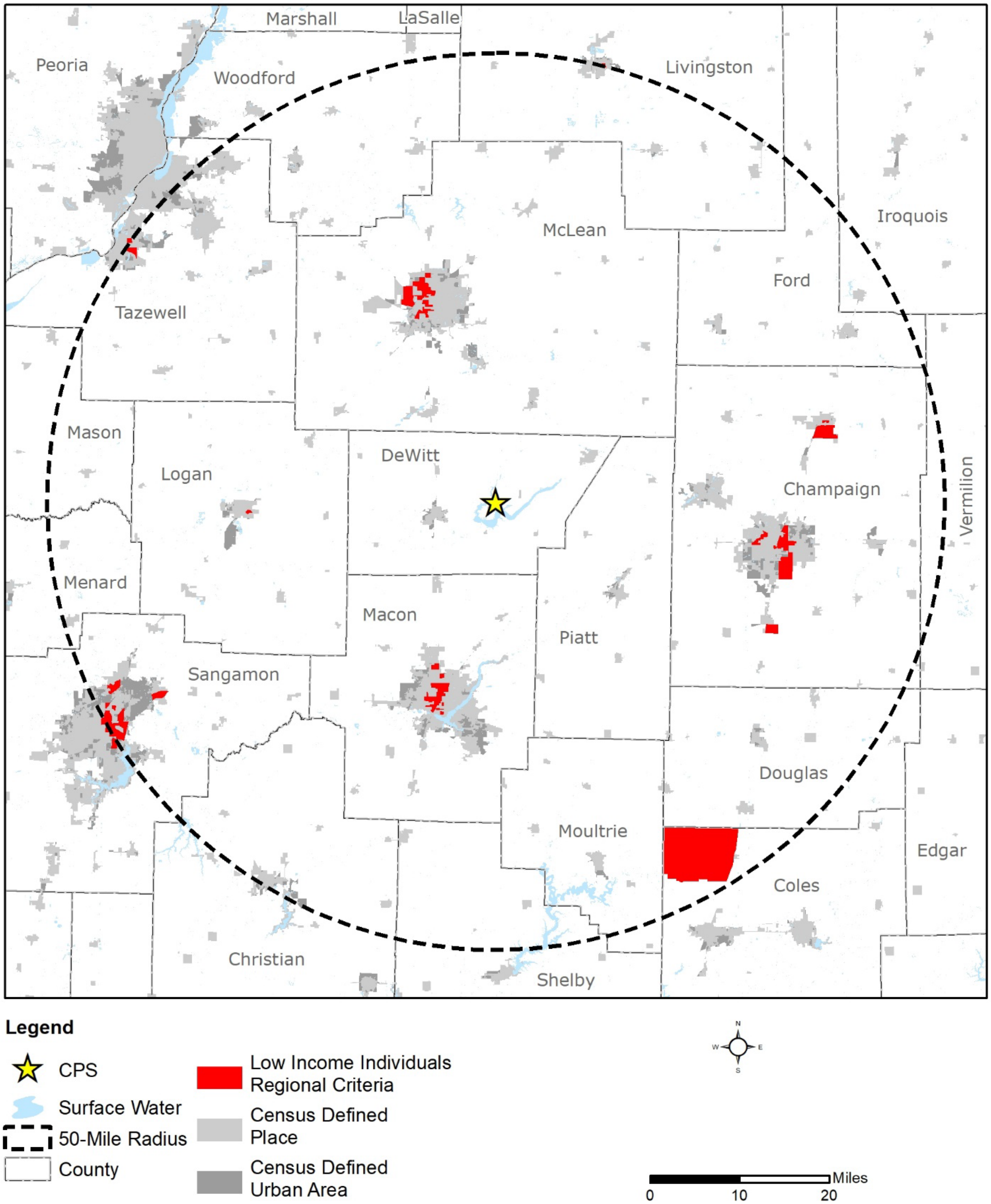


Figure 3.11-13 Low Income Individuals (Regional)

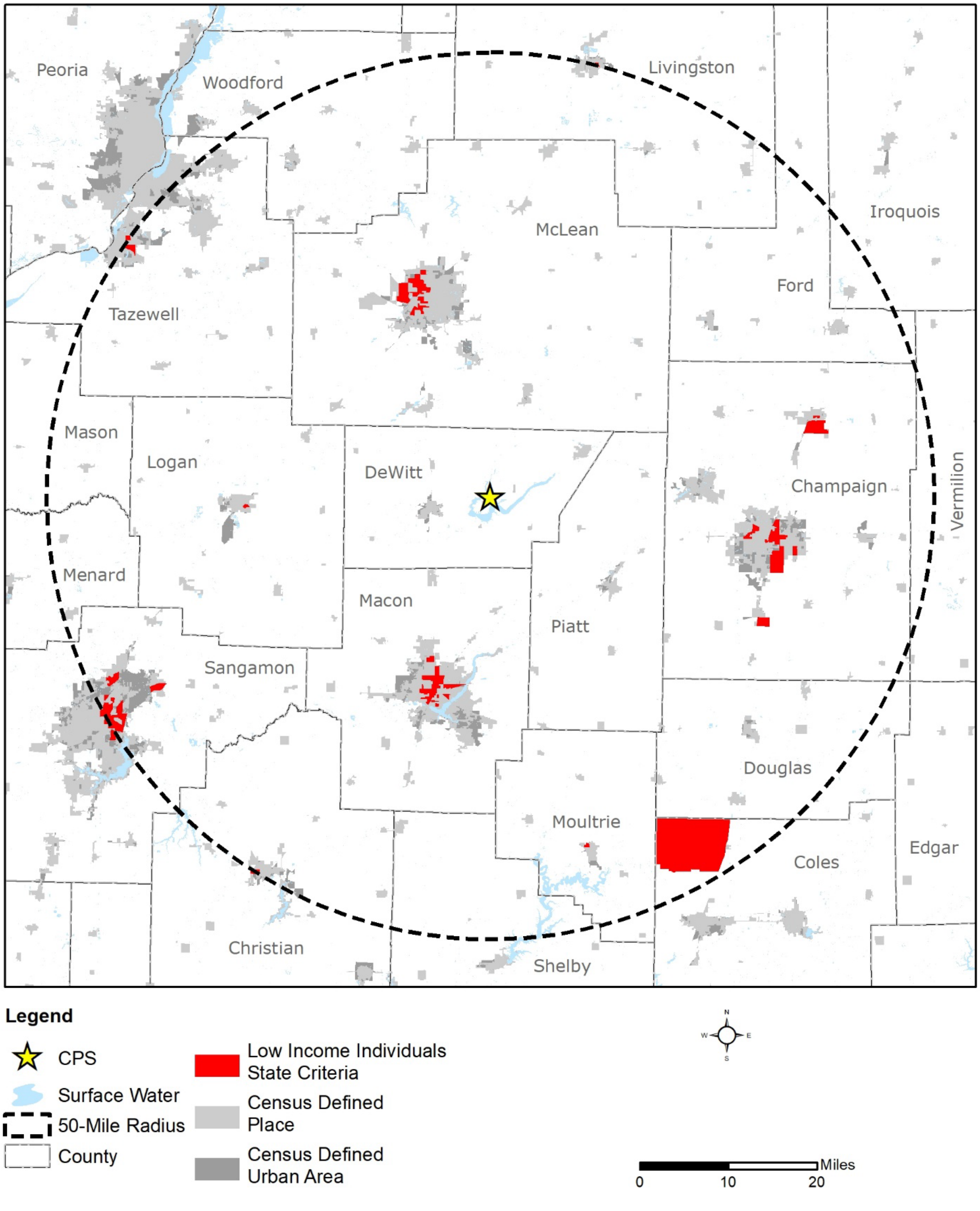


Figure 3.11-14 Low Income Individuals (Individual State)

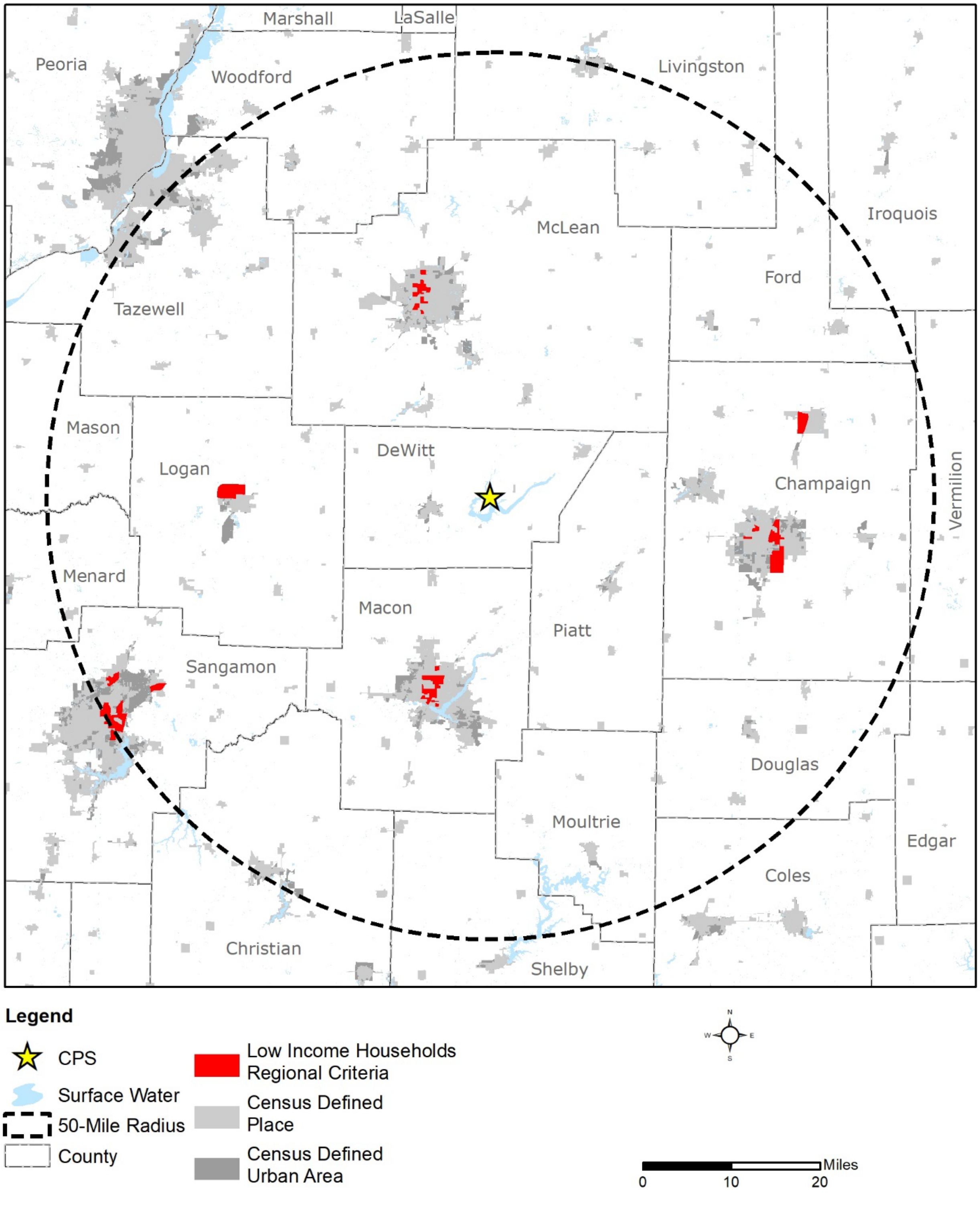


Figure 3.11-15 Low Income Households (Regional)

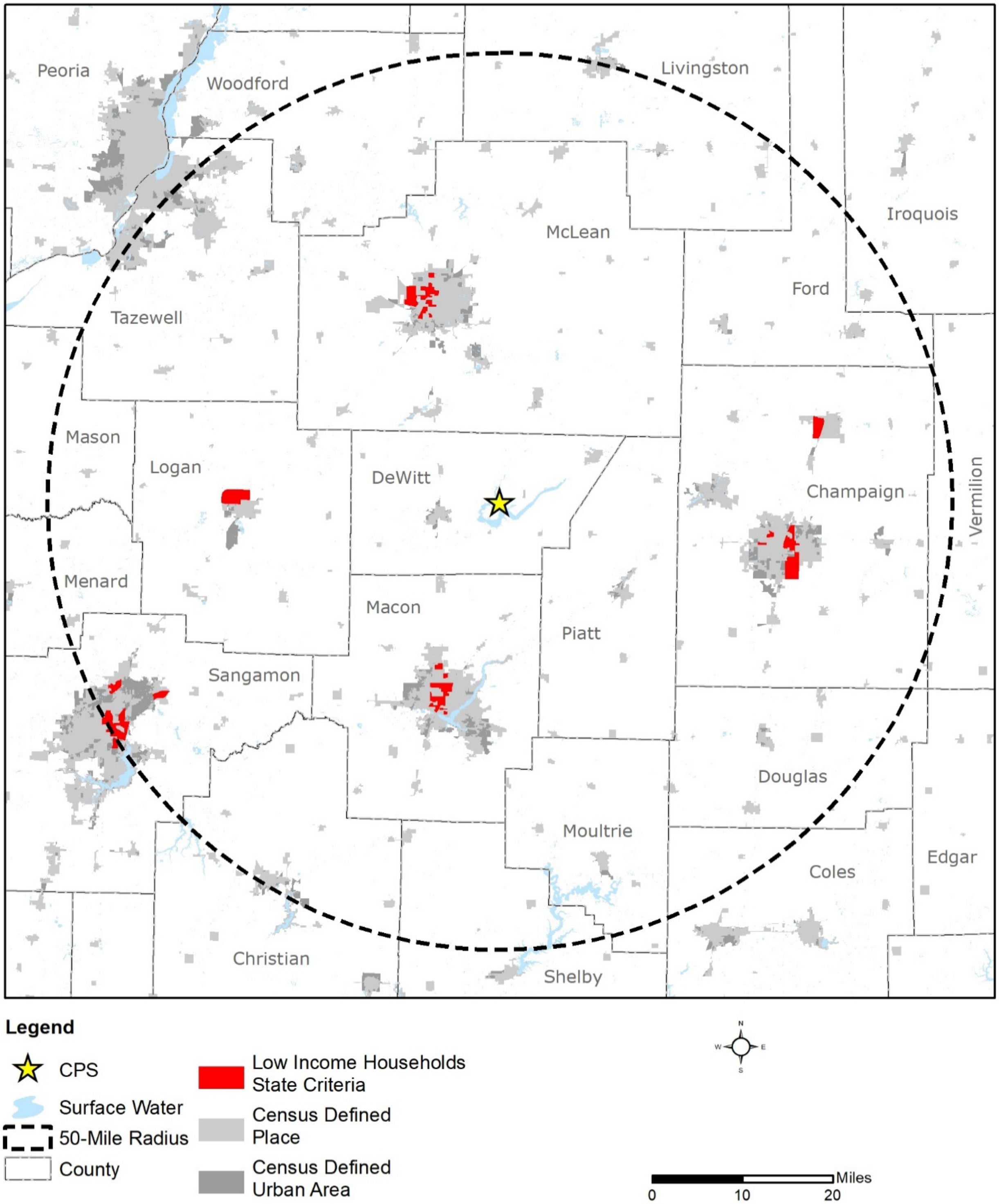


Figure 3.11-16 Low Income Households (Individual State)

3.12 Waste Management

In addressing a plant's radioactive and nonradioactive waste management systems and programs, NRC Regulatory Guide 4.2, Supplement 1, Revision 1, specifies that the information being requested in this section can be incorporated by reference to Section 2.2 of the ER (NRC 2013b). Therefore, consistent with NRC Regulatory Guide 4.2, CEG is providing the information below to address CPS's radioactive and nonradioactive waste management systems and programs.

3.12.1 Radioactive Waste Management

Section 2.2.6 includes a discussion of CPS's liquid, gaseous, and solid radwaste systems. The section provides a description of the systems, management of low-level mixed waste, radwaste storage, spent fuel storage, and permitted facilities currently utilized for offsite processing and disposal of radioactive wastes.

3.12.2 Nonradioactive Waste Management

Section 2.2.7 includes a discussion of CPS's RCRA nonradioactive waste management program, types of waste generated, waste minimization practices, and permitted facilities currently utilized for disposition of wastes.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND MITIGATING ACTIONS

The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues [10 CFR 51.53(c)(3)(iii)].

> *The report must contain a consideration of alternatives for reducing adverse impacts . . . for all Category 2 license renewal issues . . . . [10 CFR 51.53(c)(3)(iii)]*
>
> *The environmental report must include an analysis that considers . . . the environmental effects of the proposed action . . . and alternatives available for reducing or avoiding adverse environmental effects. [10 CFR 51.45(c)]*
>
> *The environmental report shall . . . discuss . . . the impact of the proposed action on the environment. Impacts shall be discussed in proportion to their significance. [10 CFR 51.45(b)(1)]*
>
> *The information submitted . . . should not be confined to information supporting the proposed action but should also include adverse information. [10 CFR 51.45(e)]*

The NRC has identified and analyzed 78 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated these issues as Category 1, Category 2, or uncategorized. The NRC designated an issue as Category 1 if the following criteria were met:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for offsite radiological impacts-collective impacts from other than the disposal of spent fuel and high-level waste).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely to be not sufficiently beneficial to warrant implementation.

If the NRC concluded that one or more of the Category 1 criteria could not be met, the NRC designated the issue Category 2, which requires plant-specific analysis. The NRC designated one issue as uncategorized (chronic effects of electromagnetic fields), signifying that the categorization and impact definitions do not apply to this issue. Until such time that this uncategorized issue is categorized, applicants for license renewal are not required to submit information on this issue [10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 6]; therefore, this issue is not included in Tables 4.0-1, 4.0-2, or 4.0-3, nor is it addressed in Section 4.9. NRC rules do not require analyses of Category 1 issues that were resolved using generic findings [10 CFR 51, Subpart A, Appendix B, Table B-1] as described in the GEIS. Therefore, an applicant may reference the GEIS findings for Category 1 issues, absent new and significant information. The NRC provides guidance on new and significant information in Regulatory Guide 4.2, Supplement 1, Revision 1 (NRC 2013b). In this guidance, new and significant information is defined as follows:

- Information that identifies a significant environmental issue not considered or addressed in the GEIS and consequently, not codified in Table B-1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Plants, in Appendix B, Environmental Effect of Renewing the Operating License of a Nuclear Power Plant, to Subpart A, National Environmental Policy Act-Regulations Implementing Section 102(2), of 10 CFR 51; or

- Information not considered in the assessment of impacts evaluated in the GEIS, leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1.

- Further, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity and/or scope (context) not previously recognized.

4.0.1 Category 1 License Renewal Issues

The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in Appendix B to subpart A of this part. [10 CFR 51.53(c)(3)(i)]

[A]bsent new and significant information, the analyses for certain impacts codified by this rulemaking need only be incorporated by reference in an applicant's environmental report for license renewal . . . . (61 FR 28483)

CEG has determined that, of the 60 Category 1 issues, six are not applicable to CPS. Table 4.0-1 lists these issues and provides a brief explanation of why they are not applicable to the site. Table 4.0-2 lists the issues which are applicable to the site. CEG reviewed the NRC findings on these issues and identified no new and significant information that would invalidate the findings for the site (Chapter 5). Therefore, CEG adopts by reference the NRC findings for these Category 1 issues.

4.0.2 Category 2 License Renewal Issues

The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to subpart A of this part. [10 CFR 51.53(c)(3)(ii)]

The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues . . . . [10 CFR 1.53(c)(3)(iii)]

The NRC designated 17 issues as Category 2 (Table 4.0-3). CEG has determined that six issues are not applicable to CPS. For the issues applicable to the site, the corresponding sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to renewal of the CPS OL and, when applicable, discuss potential mitigation alternatives to the extent appropriate. With the exception of threatened and endangered species/EFH, historic and cultural resources, and environmental justice, CEG has identified the significance of the impacts associated with each issue as SMALL, MODERATE, or LARGE, consistent with the criteria that the NRC established in 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3 as follows:

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource. For issues where probability is a key consideration (i.e., accident consequences), probability was a factor in determining significance.

Consistent with NRC guidance, CEG identified the significance of the impacts for the three Category 2 issues of threatened and endangered species/EFH, historic and cultural resources, and environmental justice as follows:

- For threatened and endangered species (per the ESA), the significance of the effects from license renewal can be characterized based on a determination of whether continued nuclear power plant operations, including refurbishment, (1) would have no effect on federally listed species; (2) are not likely to adversely affect federally listed species; (3) are likely to adversely affect federally listed species; or (4) are likely to jeopardize a federally listed species or adversely modify designated critical habitat. For EFH (per the Magnuson Stevens Fishery Conservation and Management Act), the significance of effects from license renewal can be characterized based on a determination of whether continued nuclear power plant operations, including refurbishment, would have: (1) no adverse impact; (2) minimal adverse impact; or (3) substantial adverse impact to the essential habitat of federally managed fish populations. (NRC 2013a)

- For historic and cultural resources (per the NHPA), the significance of the effects from license renewal can be characterized based on a determination that: (1) no historic properties are present (no effect); (2) historic properties are present but would not be adversely affected (no adverse effect); or (3) historic properties are adversely affected (adverse effect). (NRC 2013b)

- For environmental justice, impacts would be based on disproportionately high and adverse human health and environmental effects on minority and low-income populations. (NRC 2013b)

In accordance with National Environmental Policy Act (NEPA) practice, CEG considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are SMALL receive less mitigation consideration than impacts that are LARGE).

4.0.3 Not Applicable License Renewal Issues

The NRC determined that its categorization and impact-finding definitions did not apply to chronic effects of electromagnetic fields. Because the categorization and impact finding definitions do not apply as noted in 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 5, applicants are not currently required to submit information on this issue.

4.0.4 Format of Issues Reviewed

Chapter 4 follows Regulatory Guide 4.2, Supplement 1, Revision 1 (NRC 2013b) regarding content for the license renewal issues identified in 10 CFR 51, Subpart A, Appendix B, Table B-1. For Category 1 issues, the generic issues resolved by NRC in the GEIS (NRC 2013a), CEG presents the results of its new and significant information review. For Category 2 issues which were not resolved in the GEIS, CEG presents a site-specific analysis. The format for Category 2 issues is described below.

- Issue: Title of the issue.
- Findings from 10 CFR 51, Subpart A, Appendix B, Table B-1: The findings for the issue from 10 CFR 51, Subpart A, Appendix B, Table B-1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants.
- Requirement: Restatement of the applicable 10 CFR 51.53 requirement.
- Background: A background excerpt from the applicable section of the GEIS. The specific section of the GEIS is referenced for the convenience of the reader.

- Analysis: An analysis of the environmental impact, considering information provided in the GEIS and 10 CFR 51, Subpart A, Appendix B, as well as current site-specific information. If an issue is not applicable, the analysis lists the explanation. The analysis section also provides a summary conclusion of the environmental impacts and identifies, as applicable, either ongoing or additional planned mitigation measures to reduce adverse impacts.

Table 4.0-1 Category 1 Issues Not Applicable to CPS

Issue	Comment
Land Use	
Offsite land use in transmission line rights-of-way (ROWs)	All in-scope transmission lines subject to the evaluation of environmental impacts for license renewal are located completely within the CPS site boundaries.
Surface Water Resources	
Altered salinity gradients	CPS does not discharge to an estuary.
Groundwater Resources	
Groundwater quality degradation resulting from water withdrawals	CPS does not use groundwater for operations either in station systems or for potable water to support operations.
Groundwater quality degradation (plants with cooling ponds in salt marshes)	CPS is located alongside freshwater bodies.
Aquatic Resources	
Impingement and entrainment of aquatic organisms (plants with cooling towers)	CPS cooling towers provide single pass-through cooling, withdrawing from and returning water to the discharge flume, a channel constructed to convey the heated condenser cooling water to Clinton Lake.
Thermal impacts on aquatic organisms (plants with cooling towers)	CPS cooling towers provide single pass-through cooling, withdrawing from and returning water to the discharge flume, a channel constructed to convey the heated condenser cooling water to Clinton Lake.

Table 4.0-2 Category 1 Issues Applicable to CPS (Sheet 1 of 3)

Resource	Issue
Land Use	Onsite land uses
	Offsite land uses
Visual Resources	Aesthetic impacts
Air Quality	Air quality impacts (all plants)
	Air quality effects of transmission lines
Noise	Noise impacts
Geologic Environment	Geology and soils
Surface Water Resources	Surface water use and quality (non-cooling system impacts)
	Altered current patterns at intake and discharge structures
	Effects of dredging on surface water quality
	Scouring caused by discharged cooling water
	Discharge of metals in cooling system effluent
	Discharge of biocides, sanitary wastes, and minor chemical spills
	Surface water use conflicts (plants with once-through cooling systems)
	Temperature effects on sediment transport capacity
Groundwater Resources	Groundwater contamination and use (non-cooling system impacts)
	Groundwater use conflicts (plants that withdraw less than 100 gpm)

Table 4.0-2 Category 1 Issues Applicable to CPS (Sheet 2 of 3)

Resource	Issue
Terrestrial Resources	Exposure of terrestrial organisms to radionuclides
	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)
	Cooling tower impacts on vegetation (plants with cooling towers)
	Bird collisions with plant structures and transmission lines
	Transmission line ROW management impacts on terrestrial resources
	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)
	Entrainment of phytoplankton and zooplankton (all plants)
	Infrequently reported thermal impacts (all plants)
	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication
	Effects of non-radiological contaminants on aquatic organisms
	Exposure of aquatic organisms to radionuclides
	Effects of dredging on aquatic organisms
	Effects on aquatic resources (non-cooling system impacts)
	Impacts of transmission line ROW management on aquatic resources
	Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses
Socioeconomics	Employment and income, recreation, and tourism
	Tax revenues
	Community services and education
	Population and housing
	Transportation

Table 4.0-2 Category 1 Issues Applicable to CPS (Sheet 3 of 3)

Resource	Issue
Human Health	Radiation exposures to the public
	Radiation exposures to plant workers
	Human health impact from chemicals
	Microbiological hazards to plant workers
	Physical occupational hazards
Postulated Accidents	Design-basis accidents
Waste Management	Low-level waste storage and disposal
	Onsite storage of spent nuclear fuel
	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal
	Mixed-waste storage and disposal
	Nonradioactive waste storage and disposal
Uranium Fuel Cycle	Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste
	Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste
	Non-radiological impacts of the uranium fuel cycle
	Transportation
Termination of Nuclear Power Plant Operations and Decommissioning	Termination of plant operations and decommissioning

Table 4.0-3 Category 2 Issues Applicability to CPS (Sheet 1 of 2)

Resource Issue	Applicability	ER Section
Surface Water Resources		
Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river)	Not Applicable	4.5.1
Groundwater Resources		
Groundwater use conflicts (plants that withdraw more than 100 gpm)	Not Applicable	4.5.3
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river)	Not Applicable	4.5.2
Groundwater quality degradation (plants with cooling ponds at inland sites)	Not Applicable	4.5.4
Radionuclides released to groundwater	Applicable	4.5.5
Terrestrial Resources		
Effects on terrestrial resources (non-cooling system impacts)	Applicable	4.6.5
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	Not Applicable	4.6.4
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	Applicable	4.6.1
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	Applicable	4.6.2
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	Not Applicable	4.6.3
Special Status Species and Habitats		
Threatened, endangered, and protected species and EFH	Applicable	4.6.6
Historic and Cultural Resources		
Historic and cultural resources	Applicable	4.7

Table 4.0-3 Category 2 Issues Applicability to CPS (Sheet 2 of 2)

Resource Issue	Applicability	ER Section
Human Health		
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river) **Note**: 10 CFR 51, Subpart A, Appendix B, Table B-1 finding states, "These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals, or that discharge into rivers." Thus, including plants using lakes for cooling as plants where this Category 2 issue is applicable.	Applicable	4.9.1
Electric shock hazards	Applicable	4.9.2
Postulated Accidents		
Severe accidents	Applicable	4.15
Environmental Justice		
Minority and low-income populations	Applicable	4.10.1
Cumulative Impacts		
Cumulative Impacts	Applicable	4.12

4.1 Land Use and Visual Resources

Impacts to land use and visual resources are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to land use and visual resources. Therefore, CEG incorporates the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.2 Air Quality

Impacts to air quality are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to air quality. Therefore, CEG incorporates the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.3 Noise

Impacts to noise are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to noise. Therefore, CEG incorporates the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.4 Geology and Soils

Impacts to geology and soils are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to geology and soils. Therefore, CEG incorporates the findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.5 Water Resources

Impacts to water resources evaluated in the GEIS and considered to be generic (the same or similar at all plants), or Category 1 are listed in Section 4.0. CEG conducted a new and significant information review and identified no new and significant information related to water resources Category 1 issues. Therefore, CEG incorporates the findings of NRC Finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The Category 2 issues for water resources are discussed below.

4.5.1 Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.5.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts could be of small or moderate significance, depending on makeup water requirements, water availability, and completing water demands.

4.5.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river…must be provided.

4.5.1.3 Background [GEIS Section 4.5.1.1]

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users. Closed-cycle cooling is not completely closed, because the system discharges blowdown water to a surface water body and withdraws water for makeup of both the consumptive water loss due to evaporation and drift (for cooling towers) and blowdown discharge. For plants using cooling towers, the makeup water needed to replenish the consumptive loss of water to evaporation can be significant and is reported at 60 percent or more of the condenser flow rate. Cooling ponds will also require makeup water as a result of naturally occurring evaporation, evaporation of the warm effluent, and possible seepage to groundwater.

Consumptive use by plants with cooling ponds or cooling towers using makeup water from a river during the license renewal term is not expected to change unless power uprates, with associated increases in water use, are proposed. Such uprates would require an environmental assessment by the NRC. In the 1996 GEIS, application of this issue applied only to rivers with low flow so as to define the difference between plants located on "small" versus "large" rivers. However, any river, regardless of size, can experience low flow conditions of varying severity during periods of drought and changing conditions in the affected watershed such as upstream diversions and use of river water. NRC has subsequently determined that use of the term "low flow" in categorizing river flow is of little value considering that all rivers can experience low flow conditions.

Population growth around nuclear power plants has caused increased demand on municipal water systems, including systems that rely on surface water. Municipal intakes located downstream from a nuclear power plant could experience water shortages, especially in times of drought. Similarly, water demands upstream from a plant could impact the water availability at the plant's intake.

Water use conflicts associated with plants with cooling ponds or cooling towers using makeup water from a river with low flow were considered to vary among sites because of differing site-specific factors, such as makeup water requirements, water availability (especially in terms of varying river flow rates), changing or anticipated changes in population distributions, or changes in agricultural or industrial demands.

4.5.1.4 Analysis

As presented in Section 2.2.3.1, CPS uses a once-through cooling system and MDCTs on the south side of the discharge flume, typically from May through September. CPS does not use a closed-cycle system for condenser circulating water cooling; therefore, this issue does not apply, and further analysis is not required.

4.5.2 Groundwater Use Conflicts (Plants with Closed-Cycle Cooling Systems that Withdraw Makeup Water from a River)

4.5.2.1 Findings from 10 CFR 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Water use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands.

4.5.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant uses cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands…must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

4.5.2.3 Background [GEIS Section 4.5.1.2]

In the case of plants with cooling towers or cooling ponds that rely on a river for makeup of consumed (evaporated) cooling water, it is possible water withdrawals from the river could lead to groundwater use conflicts with other users. This situation could occur because of the interaction between groundwater and surface water, especially in the setting of an alluvial aquifer in a river valley. Consumptive use of the river water, if significant enough to lower the river's water level, would also influence water levels in the alluvial aquifer. Shallow wells of nearby groundwater users could therefore have reduced water availability or go dry. During times of drought, the effect would occur naturally, although withdrawals for makeup water would increase the effect.

4.5.2.4 Analysis

As presented in Section 2.2.3.1, CPS uses a once-through cooling system and MDCTs. CPS does not use a closed-cycle system for condenser circulating water cooling; therefore, this issue does not apply, and further analysis is not required.

4.5.3 Groundwater Use Conflicts (Plants that Withdraw More Than 100 GPM)

4.5.3.1 Findings from 10 CFR 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Plants that withdraw more than 100 gpm could cause groundwater use conflicts with nearby groundwater users.

4.5.3.2 Requirement [10 CFR 51.53(c)(3)(ii)(C)]

If the applicant's plant pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater must be provided.

4.5.3.3 Background [GEIS Section 4.5.1.2]

A nuclear plant may have several wells with combined pumping in excess of 100 gpm (378 liters per minute [L/min]). Overall site pumping rates of this magnitude have the potential to create conflicts with other local groundwater users if the cone of depression extends to the offsite well(s). Large offsite pumping rates for municipal, industrial, or agricultural purposes may, in turn, lower the water level at power plant wells. For any user, allocation is normally determined through a state-issued permit.

Groundwater use conflicts have not been observed at any nuclear power plants, and no significant change in water well systems is expected over the license renewal term. If a conflict did occur, it might be possible to resolve it if the power plant relocated its well or wellfield to a different part of the property, The siting of new wells would be determined through a hydrogeologic assessment.

4.5.3.4 Analysis

As presented in Section 3.6.3.2, CPS does not withdraw groundwater for station purposes. However, there is a groundwater well at the personnel beach recreation area south of the station that is used to provide potable water as needed and is shut down during winter months. The groundwater withdrawal rate is not measured in this well; however, because groundwater use from this well is intermittent, of limited capacity, and for potable use only during summer months when the recreational area is open, groundwater withdrawals are expected to be significantly less than 100 gpm. It is not anticipated that groundwater withdrawals from this well would change significantly during the LR term. Therefore, this issue is not applicable and further analysis is not required.

4.5.4 Groundwater Quality Degradation (Plants with Cooling Ponds at Inland Sites)

4.5.4.1 Findings from 10 CFR 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Inland sites with closed-cycle cooling ponds could degrade groundwater quality. The significance of the impact would depend on cooling pond water quality, site hydrogeologic conditions (including the interaction of surface and groundwater), and the location, depth, and pump rate of water wells.

4.5.4.2 Requirement [10 CFR 51.53(c)(3)(ii)(D)]

If the applicant's plant is located at an inland site and uses cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided.

4.5.4.3 Background [GEIS Section 4.5.1.2]

Some nuclear power plants that rely on unlined cooling ponds are located at inland sites surrounded by farmland or forest or undeveloped open land. Degraded groundwater has the potential to flow radially from the ponds and reach offsite groundwater wells. The degree to which this occurs depends on the water quality of the cooling pond; site hydrogeologic conditions (including the interaction of surface water and groundwater); and the location, depth, and pump rate of water wells. Mitigation of significant problems stemming from this issue could include lining existing ponds, constructing new lined ponds, or installing subsurface flow barrier walls. Groundwater monitoring networks would be necessary to detect and evaluate groundwater quality degradation. The degradation of groundwater quality associated with cooling ponds has not been reported for any inland nuclear plant sites.

4.5.4.4 Analysis

As presented in Section 2.2.3.1 and Section 4.5.1 of this ER, CPS uses a once-through cooling system and MDCTs but does not use cooling ponds. Therefore, this issue is not applicable and further analysis is not required.

4.5.5 Radionuclides Released to Groundwater

4.5.5.1 Findings from 10 CFR 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Leaks of radioactive liquids from plant components and pipes have occurred at numerous plants. Groundwater protection programs have been established at all operating nuclear power plants to minimize the potential impact from any inadvertent releases. The magnitude of impacts would depend on site-specific characteristics.

4.5.5.2 Requirement [10 CFR 51.53(c)(3)(ii)(P)]

An applicant shall assess the impact of any documented inadvertent releases of radionuclides into groundwater. The applicant shall include in its assessment a description of any groundwater protection program used for the surveillance of piping and components containing radioactive liquids for which a pathway to groundwater may exist. The assessment must also include a description of any past inadvertent releases and the projected impact to the environment (e.g., aquifers, rivers, lakes, ponds, ocean) during the license renewal term.

4.5.5.3 Background [GEIS Section 4.5.1.2]

The issue is relevant to license renewal because all commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment. These radioactive releases are designed to be planned, monitored, documented, and released into the environment at designated discharge points. But over the years, there have been numerous events at nuclear power reactor sites that involved unknown, uncontrolled, and unmonitored releases of liquids containing radioactive material into the groundwater.

The majority of the inadvertent liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, other radioactive isotopes, such as cesium and strontium, have also been inadvertently released into groundwater. The types of events include leakage from spent fuel pools, buried piping, and failed pressure relief valves on an effluent discharge line.

In 2006, the NRC's executive director for operations chartered a task force to conduct a lessons learned review of these incidents. On September 1, 2006, the task force issued its report: Liquid Radioactive Release Lessons Learned Task Force Report.

The most significant conclusion dealt with the potential health impacts on the public from the inadvertent releases. Although there were numerous events during which radioactive liquid was released to the groundwater in an unplanned, uncontrolled, and unmonitored fashion, based on the data available, the task force did not identify any instances where public health and safety were adversely impacted.

On the basis of information and experience with these leaks, the NRC concludes that the impact to groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, the radionuclides involved, hydrogeologic factors, the distance of receptors, and the response time of plant personnel in identifying and stopping the leak in a timely fashion.

4.5.5.4 Analysis

A description of the CPS RGPP is presented in Section 3.6.2.4. Table 3.6-3 presents well construction details for the CPS groundwater monitoring wells, and Figure 3.6-7 shows the locations of the onsite wells. Table 3.6-7 presents information on 19 registered offsite water wells within a 2-mile radius of the CPS center point, and Figure 3.6-10 shows the locations of these offsite wells.

As presented in Section 3.6.3.1, there have been no liquid radioactive liquid releases at CPS since 1992 and there are no plans for future liquid radioactive liquid releases. As presented in Section 3.6.4.2.1, there were no gaseous effluent releases that approached the limits specified in the CPS ODCM. However, tritium has been detected in shallow groundwater likely from a release from the former cycled condensate storage tank, located northeast of the turbine and radwaste buildings, which occurred circa 2006. Groundwater impacts related to this release are monitored under the RGPP. The extent of tritium impact has been limited to shallow groundwater near the tank. The maximum detected tritium concentration in the last 5 years (2018–2022) was in March 2021 from monitoring well MW-CL-14S at 1,500 ± 219 pCi/L, which is significantly below the EPA drinking water limit of 20,000 pCi/L.

As presented in Section 3.6.4.2, tritium has not been detected in any of the intermediate wells at CPS in the last 5 years. As discussed in Section 3.6.2.3, shallow groundwater inflow in the PA area is likely discharged to Clinton Lake, and as shown in Figure 3.6-9, groundwater in the intermediate zone discharges to Clinton Lake. However, as described in Section 3.6.4.1, tritium has not been detected in surface water samples at CPS. As described in Section 3.6.1, potable water at CPS is supplied from Clinton Lake. As part of its REMP, CPS collects monthly drinking water samples for radionuclides analysis. Radionuclides were not detected above their respective LLDs in 2018 through 2022; therefore, radionuclides exposure from the onsite potable water source is not an issue at CPS. (CEG 2023; EGC 2019a; EGC 2020b; EGC 2021b; EGC 2022a) In addition, based on analytical results, there is minimal potential for tritium exposure from recreational activities in surface water from groundwater migration.

As described in Section 3.6.3.2, bedrock aquifers are not typically used for domestic water supply in the CPS area. As shown in Figure 3.6-10, there are no offsite domestic water supply wells between CPS and discharge points. Therefore, it is highly unlikely that offsite water supply wells could be impacted from a potential tritium release to groundwater.

The effects of accidental releases of liquid effluents in surface waters are evaluated for components containing liquid radioactive materials located outside the containment building. The two 10,000-gallon phase separator tanks are in separate concrete cells in the basement of the Radwaste Building below the ambient groundwater level. Therefore, the only way any effluents released accidentally can reach a surface water body is by entering the surrounding groundwater. (EGC 2020a) Because the ambient groundwater elevation is more than 20 feet higher than the fluid level inside the concrete cells, groundwater would be forced into the building if a cell were to crack. Therefore, it is unlikely that any radioactive effluent would be released from the building to groundwater. The only waste storage tanks above grade are the concentrate waste tanks in the radwaste building. If one of the tanks ruptured, the contents would reach the building basement through the floor drain system and be contained due to high groundwater level. (EGC 2020a)

Since water from station usage continues to be processed and monitored in compliance with licensing and permitting, CEG concludes that impacts from radionuclides released to groundwater during the proposed LR term are SMALL and do not warrant additional mitigation measures beyond CPS's existing RGPP.

4.6 Ecological Resources

Impacts to ecological resources evaluated in the GEIS and considered to be generic (the same or similar at all plants), or Category 1 are listed in Section 4.0. CEG conducted a new and significant information review and identified no new and significant information related to ecological resources Category 1 issues. Therefore, CEG incorporates the findings of NRC Finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The Category 2 issues for ecological resources are discussed below.

4.6.1 Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

4.6.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, OR LARGE. The impacts of impingement and entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling pond cooling systems, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site.

4.6.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant’s plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current CWA 316(b) determinations or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from impingement and entrainment.

4.6.1.3 Background [GEIS Section 4.6.1.2]

Impingement occurs when organisms are held against the intake screen or netting placed within intake canals. Most impingement involves fish and shellfish. At some nuclear power plants, other vertebrate species may also be impinged on the traveling screens or on intake netting placed within intake canals.

Entrainment occurs when organisms pass through the intake screens and travel through the condenser cooling system. Aquatic organisms typically entrained include ichthyoplankton (fish eggs and larvae), larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. Juveniles and adults of some species may also be entrained if they are small enough to pass through the intake screen openings, which are commonly 0.38 inches at the widest point.

The magnitude of the impact would depend on plant-specific characteristics of the cooling system (including location, intake velocities, screening techniques, and withdrawal rates) and characteristics of the aquatic resource (including population distribution, status, management objectives, and life history).

4.6.1.4 Analysis

In accordance with the statutory guidelines set forth in the NPDES permit issued to CEG for CPS, and to maintain compliance under Section 316(b) of the CWA, periodic monitoring of entrainment and impingement of fish and aquatic species is conducted to verify that CPS is utilizing BTA available to reduce entrainment and impingement. The current NPDES permit (Attachment B) was issued in March 2020, modified in May 2021, and is valid through March 2025.

Entrainment monitoring was conducted at CPS in 2019–2020. Impingement studies were also conducted at CPS during two time periods: 1987–1988 and 2005–2007. These entrainment and impingement studies are detail in Section 3.7.7.

During the yearlong impingement study from May 1987–April 1988, a total of eight fish species were collected, but impingement was almost exclusively gizzard shad (43,369,805 individuals caught). Gizzard shad have high mortality rates when water temperatures begin to decrease in the fall and remain cold throughout the winter. YOY shad have a high mortality rate during this period, which may be as high as 99.9 percent. The shad become disoriented and distressed when water temperatures reach 6ºC to 7ºC, and suffer mortality when temperatures decrease to 3ºC or 4ºC. Peak impingement at CPS correlated with low water temperatures, as the average water temperatures for December and January were 4ºC, and 6ºC for February and March. Therefore, impinged gizzard shad were mostly moribund. In promulgating the Existing Facilities Rule, EPA excluded fish that were dead at time zero from the calculation of latent impingement mortality because those counts did not measure mortal harm caused by impingement and may "reflect already injured, nearly dead, or already dead fish (''naturally moribund'') that were impinged by the screen" (79 FR 48323). Since the majority of overall impingement at CPS is gizzard shad during winter months, very little impingement mortality is related to operation of the CWIS. In addition to gizzard shad, three species had a total estimated impingement between May 1987 and April 1988 over 100 individuals: white crappie, freshwater drum, and black bullhead. White crappie (2,338 individuals) were impinged between April and October, with peak impingement in August (791 individuals). Freshwater drum (758 individuals) were impinged between March and November, with peaks in impingement in April (196 individuals) and October (155 individuals). Black bullhead (148 individuals) were only impinged in May and July through September, peaking in September (70 individuals).

During the 2005–2007 study at CPS, a total of 5 fish species were caught. Similar to the 1987–1988 study, this study also recorded increases in impingement as water temperatures began to fall. During the first year of the study, peak impingement occurred in March, with an estimated 180,937 fish, which accounts for 31 percent of the estimated annual impingement. March, November, and October accounted for 70.3 percent of the estimated annual impingement. Impingement was lowest in May, with an estimated 1,456 fish impinged, accounting for 0.3 percent of the estimated annual impingement. Impingement remained low from June through August. In the second year of the study, impingement increased in the winter months and peaked in February, accounting for 45.7 percent of the estimated annual impingement. Impingement from January through March accounted for approximately 80 percent of the annual estimated impingement for year two. Impingement was lowest in May and June, with 1,586 and 1,830 fish impinged, respectively.

Although no newer impingement studies have been conducted since the 2005–2007 study, both the 1987–1998 and 2005–2007 studies conducted at CPS indicate that impingement is primarily driven by seasonal patterns, rather than due to continued operations of CPS. As described above, impingement events were primarily driven by decreases in water temperature, and gizzard shad mortality was due to cold temperatures. As water temperatures warmed in the spring, impingement rates significantly decreased. Periods of impingement of white bass and black crappie in Clinton Lake were attributed to severe fungal infections that occurred in the fall of 2005 and winter of 2006. Certain seasonal conditions in the lake may trigger fungal growth and increase infection rates within the lake, resulting in increased impingement of susceptible species.

Another mitigating factor with respect to impingement and entrainment at CPS is the approach velocity of water at the CWIS. The CWIS was originally designed with 14 bays for two potential operating units; however, since seven bays are unused for Unit 2 and are not connected to the other bays, the approach velocity for a single unit (Unit 1) is less than originally planned. Hence the operation of just seven bays instead of 14 likely contributes to lower impingement and entrainment rates and will continue during the proposed LR term.

The CPS facility has operated under a NPDES permit and has been withdrawing cooling water from Clinton Lake without any identified problems with respect to impingement or entrainment. CPS will ensure that it continues to utilize the BTA to minimize entrainment and impingement to the fullest extent practicable to maintain compliance with the NPDES permit.

Based on previous impingement and entrainment studies, ecological monitoring, and compliance with NPDES permit conditions, CEG concludes that impacts from impingement and entrainment of aquatic organisms during the proposed LR term would be SMALL.

4.6.2 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

4.6.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Most of the effects associated with thermal discharges are localized and not expected to affect overall stability of populations or resources. The magnitude of impacts, however, would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area.

4.6.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of a 316(a) variance in accordance with 40 CFR Part 125, or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from thermal changes.

4.6.2.3 Background [GEIS Section 4.6.1.2]

Because characteristics of both the thermal discharges and the affected aquatic resources are specific to each site, NRC classified heat shock as a Category 2 issues that required a site-specific assessment for license renewal. The NRC found the potential for thermal discharge impacts to be greatest at plants with once-through cooling systems, primarily because of the higher discharge temperatures and larger thermal plume area compared to plants with cooling towers.

The impact level at any plant depends on the characteristics of its cooling system (including location and type of discharge structure, discharge velocity and volume, and three-dimensional characteristics of the thermal plume) and characteristics of the affected aquatic resources (including the species present and their physiology, habitat, population distribution, status, management objectives, and life history).

4.6.2.4 Analysis

As discussed in Section 3.7.7.1.5, CPS conducted a thermal modelling study in 2015 which was submitted in 2016 as part of CPS's permit renewal application in fulfillment of requirements of Title 35 Ill. Adm. Code, Section 106.1180. This study showed that the nature of the thermal discharge had not changed since the alternate thermal limits were granted and that the alternative thermal effluent limitation granted by the Illinois Pollution Control Board did not cause appreciable harm to Clinton Lake's BIC of shellfish, fish, and wildlife.

Field surveys of temperature and other relevant parameters within Clinton Lake were conducted from mid-July to mid-September 2015 in order to characterize CPS's thermal plume. The lake temperature monitoring program was designed to delineate the extent of CPS's thermal plume both spatially and temporally during periods of critical river conditions with CPS operating at or near full capacity. This program provided the data needed to map the thermal extent of the discharge and to support development of a hydrothermal model of Clinton Lake. The hydrothermal model allowed additional flexibility in assessing the potential impacts of CPS's thermal discharge over a range of lake and operating conditions that may not have been captured by the temperature monitoring program. This model was developed using existing information, data obtained from the lake temperature surveys in 2015 and data from other sources. The MIKE-3D model was applied to project near-field and far-field temperatures in CPS's discharge plume under critical conditions. Critical conditions are intended to represent worst case or extreme scenarios which are typically used to evaluate compliance with state water quality standards. Based on the model's critical case simulation, the one-day temperature at the second drop structure is 108.1°F, which is below the thermal limit set by the NPDES. Surface one-day lake temperatures up to 108°F are predicted within 0.20 miles upstream and 0.50 miles downstream of the discharge and laterally across Salt Creek. These temperatures dissipate to less than 105°F, 1.2 miles downstream of the discharge and less than 100°F, 3.3 miles upstream of the discharge.

A number of studies of the Clinton Lake fish community have been conducted over the last 30 plus years, including a study designed and conducted in 2015 that included electrofishing, beach seining, and water quality measurements. Overall, no significant differences in fish community structure and health were found between sampling locations and sampling programs, and it can be concluded that there is no evidence that the CPS thermal discharge has had any material effect on the fish community in Clinton Lake. In fact, past and recent data indicate that the general structure of the fish community in Clinton Lake has remained similar across a nearly 40-year time span. This is especially remarkable for such a heavily managed water body. In conclusion, the thermal discharge associated with CPS outflow has been demonstrated to not have any marked impact on the Clinton Lake fish community.

CPS is not required to have a permit by the IDNR regulating their surface water withdrawal and relies on the guidelines outlined in the NPDES permit. The current NPDES permit was effective as of April 1, 2020, and modified on May 3, 2021 with an expiration date of March 31, 2025, allowing CPS to operate in compliance with the existing permit.

There have been no fish kills and no NOVs related to the NPDES permit in the past 5 years (2018–2022). CPS is operating in conformance with its NPDES permit, and therefore is in compliance with CWA requirements. Through continued compliance with the NPDES permit conditions, and because there are no planned operational changes during the proposed LR term that would increase the temperature of CPS's existing thermal discharge, CEG concludes that thermal impacts on aquatic organisms during the proposed LR term would be SMALL.

4.6.3 Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.6.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts on aquatic resources in stream communities affected by water use conflicts could be of moderate significance in some situations.

4.6.3.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on stream (aquatic)… ecological communities must be provided.

4.6.3.3 Background [GEIS Section 4.6.1.2]

Increased temperatures and/or decreased rainfall would result in lower river flows, increased cooling pond evaporation, and lowered water levels in the Great Lakes or reservoirs. Regardless of overall climate change, droughts could result in problems with water supplies and allocations. Because future agricultural, municipal, and industrial users would continue to share their demands for surface water with power plants, conflicts might arise if the availability of this resource decreased.

Water use conflicts with aquatic resources could occur when water to support these resources is diminished either because of decreased water availability due to droughts; increased demand for agricultural, municipal, or industrial usage; or a combination of such factors. Water use conflicts with biological resources in stream communities are a concern due to the duration of license renewal and potentially increasing demands on surface water.

4.6.3.4 Analysis

Service and makeup water for CPS are obtained from Clinton Lake. CPS does not withdraw water from a river; therefore, this issue does not apply, and further analysis is not required.

4.6.4 Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.6.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance.

4.6.4.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action of water availability and competing water demands, the flow of the river, and related impacts on riparian (terrestrial) ecological communities must be provided.

4.6.4.3 Background [GEIS Section 4.6.1.1]

Water use conflicts with terrestrial resources in riparian communities could occur when water that supports these resources is diminished either because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of such factors. For future license renewals, the potential range of impact levels at plants with cooling ponds or cooling towers using makeup water from a river cannot be determined at this time.

4.6.4.4 Analysis

CPS does not withdraw water from a river; therefore, this issue does not apply, and further analysis is not required.

4.6.5 Effects on Terrestrial Resources (Non-Cooling System Impacts)

4.6.5.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Impacts resulting from continued operations and refurbishment associated with license renewal may affect terrestrial communities. Applications of BMPs would reduce the potential for impacts. The magnitude of impacts would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation.

4.6.5.2 Requirement [10 CFR 51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license renewal-related construction activities on important plant and animal habitats.

4.6.5.3 Background [GEIS Section 4.6.1.1]

Continued operations and refurbishment activities could continue to affect onsite terrestrial resources during the license renewal term at all operating nuclear power plants. Factors that could potentially result in impacts include landscape maintenance activities, stormwater management, and elevated noise levels. These impacts would be similar to past and ongoing impacts.

The characteristics of terrestrial habitats and wildlife communities currently on nuclear power plant sites have generally developed in response to many years of typical operations and maintenance programs. While some may have reached a relatively stable condition, some habitats and populations of some species may have continued to change gradually over time. Operations and maintenance activities during the license renewal term are expected to be similar to current activities. Because the species and habitats present on the site (i.e., weedy species and habitats they make up) are generally tolerant of disturbance, it is expected that continued operations during the license renewal term would maintain these habitats and wildlife communities in their current state or maintain current trends of change.

Terrestrial habitats and wildlife could be affected by ground disturbance from refurbishment related construction activities. Land disturbed during the construction of new ISFSIs would range from about 2.5–10 acres. Other activities may include new parking areas for plant employees, access roads, buildings, and facilities. Temporary project support areas for equipment storage, worker parking, and material laydown areas could also result in the disturbance of habitat and wildlife.

Successful application of environmental review procedures, employed by the licensees at many of the operating nuclear plant sites, would result in the identification and avoidance of important terrestrial habitats. In addition, the application of BMPs to minimize the area affected, to control fugitive dust, runoff, and erosion from project sites; to reduce the spread of invasive nonnative plant species; and to reduce wildlife disturbance in adjacent habitats, could greatly reduce the impacts of continued operations and refurbishment activities.

4.6.5.4 Analysis

4.6.5.4.1 Refurbishment Activities

As discussed in Section 2.3, no LR-related refurbishment activities have been identified. Therefore, there would be no LR-related refurbishment impacts to important plant and animal habitats, and no further analysis is required.

4.6.5.4.2 Operational Activities

Terrestrial resources are described in Section 3.7.2. No LR-related construction activities or changes in operational practices have been identified that would involve disturbing habitats. CEG would continue to conduct ongoing station operational and maintenance activities during the license renewal period.

Operational and maintenance activities that CEG might undertake during the proposed LR term, such as ISFSI pad expansion and/or maintenance and repair of station infrastructure (e.g., roadways, piping installations, fencing, and other security infrastructure), would be confined to previously disturbed areas of the site. Staging of spoil material produced as a result of potential future maintenance dredging may also occur during the proposed LR period. The requirements for the management of dredge material, including spoil storage and disposal, are determined by the NPDES permit. These activities are expected to have minimal impacts on terrestrial resources because activities would not occur in undisturbed habitats.

As discussed in Sections 3.7.6 and 9.6, CEG has administrative controls in place at the CPS site to ensure operational changes or construction activities are reviewed and any impacts minimized through implementation of BMPs, permit modifications, or acquisition of new permits as needed. In addition, regulatory programs that the site is currently subject to, such as stormwater management, spill prevention, dredging, and herbicide usage, further serve to minimize impacts to terrestrial resources.

In summary, adequate management programs and regulatory controls are in place to ensure important plant and animal habitats are protected during the proposed LR term. Therefore, CEG concludes that the impacts to terrestrial ecosystems during the proposed LR term are SMALL, and no additional mitigation measures beyond current management programs and existing regulatory controls are required.

4.6.6 Threatened, Endangered, and Protected Species, and Essential Fish Habitat

4.6.6.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

The magnitude of impacts on threatened, endangered, and protected species, critical habitat, and EFH would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether status species or habitats are present and whether they would be adversely affected by continued operations and refurbishment associated with license renewal.

4.6.6.2 Requirement [10 CFR 51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened and endangered species in accordance with federal laws protecting wildlife, including but not limited to, the ESA, and EFH in accordance with the Magnuson-Stevens Fishery Conservation and Management Act.

4.6.6.3 Background [GEIS Section 4.6.1.3]

There are several federal acts that provide protection to certain species and habitats that are treated here under a single issue. The issue includes impacts to biological resources such as threatened and endangered species and their critical habitat under the ESA, EFH as protected under the Magnuson-Stevens Fishery Conservation and Management Act and impacts to mammalian species protected under the Marine Mammal Protection Act.

Factors that could potentially result in impacts on listed terrestrial species include habitat disturbance, cooling tower drift, operation and maintenance of cooling systems, transmission line ROW maintenance, collisions with cooling towers and transmission lines, and exposure to radionuclides. The listed species on or in the vicinity of nuclear power plants also range widely, depending on numerous factors such as the plant location and habitat types present.

Potential impacts of continued operations and refurbishment activities on state or federally listed threatened and endangered species, protected marine mammals, and EFH could occur during the license renewal term. Factors that could potentially result in impacts to these species and habitats include impacts of refurbishment, other ground-disturbing activities, release of contaminants, effects of cooling water discharge on dissolved oxygen, gas supersaturation, eutrophication, thermal discharges, entrainment, impingement, reduction in water levels due to the cooling system operations, dredging, radionuclides, and transmission line ROW maintenance.

4.6.6.4 Analysis

4.6.6.4.1 Refurbishment Activities

As discussed in Section 2.3, no LR-related refurbishment activities have been identified. Therefore, there would be no LR-related refurbishment impacts to important plant and animal habitats, and no further analysis is required.

4.6.6.4.2 Operational Activities

As mentioned in Section 3.1 of this ER, total property within the CPS site boundary owned by CEG comprises 13,531 acres. Aside from the CPS station, the remainder of the site consists primarily of woodlands, pastureland, cultivated farmland, and recreational areas (CEG 2020). This provides a variety of potentially suitable habitats for native species, including threatened and endangered species.

Federally Listed Threatened and Endangered Species

As discussed in Section 3.7.8.1, there are five federally listed threatened or endangered species (northern long-eared bat, Indiana bat, rusty patched bumble bee, eastern prairie fringed orchid, Eastern Massassauga rattlesnake) that potentially occur within a 6-mile radius of CPS (USFWS 2022a, IPaC). No critical habitat for these species exists within a 6-mile radius of CPS. Additionally, the monarch butterfly (*Danaus plexippus*) is federally listed as a candidate species. Six state-listed species (including the rusty patched bumble bee, northern harrier, Kirtland's snake, spike mussel, American brook lamprey, monkeyface mussel) are listed as occurring in DeWitt County.

Potential habitat is likely to occur in the vicinity of CPS for all five federally listed species, given the large property boundaries and undeveloped areas surrounding the power station itself.

The current known ranges for the Indiana bat as well as the northern long-eared bat overlap with the CPS site (USFWS 2022d, Indiana bat; USFWS 2022e, northern long-eared bat). Suitable roosting and maternity habitat for both species is present on the CPS site; however, no occurrences of either bat species have been documented within a 1-mile radius of the CPS site. All station operations are located in disturbed areas and large tree clearing is not anticipated; however, CPS would consult with USFWS to ensure compliance with the ESA. Compliance with all regulatory requirements associated with the federally listed species will continue to be an administrative control practiced by CPS for the life of the facility; thus, the continued operation of the CPS site for the proposed LR term would have NO EFFECT on either the Indiana bat or northern long-eared bat.

Suitable habitat for the rusty patched bumble bee and the monarch butterfly is likely present in undeveloped portions of the CPS site that are not maintained by mowing. They may also use flowering plants in landscape features around the site, if present. However, according to USFWS IPaC data, the rusty patched bumble bee is considered unlikely to occur within six miles of the CPS site. (USFWS 2022a). Moreover, all plant operations are located in disturbed areas and vegetation clearing is not anticipated. Existing regulatory programs that the site is subject to including management of herbicide applications ensure that habitats and wildlife are protected. Thus, the continued operation of CPS for the proposed LR term MAY AFFECT BUT IS NOT LIKELY TO ADVERSELY AFFECT the rusty patched bumble bee and monarch butterfly.

The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetlands such as sedge meadows, marsh edges, even bogs. The CPS site is within the current known range of the eastern prairie fringed orchid and presents suitable habitat for the species. However, there have been no recorded occurrences of the species in the vicinity of the site. Moreover, all station operations are located in disturbed areas and vegetation clearing is not anticipated. As such, the continued operation of CPS during the LR term would have NO EFFECT on the eastern prairie fringed orchid.

Eastern Massasauga rattlesnakes rely on a matrix of habitats to survive, and movement among habitats that contain roads increases the potential for vehicle collision mortality. Snakes in general are prone to collision mortality, because they use road surfaces for thermoregulation and their shape, coloration, and low profile make them difficult for automobile drivers to see. However, increased automobile traffic is not anticipated to occur as a result of continued operation of CPS; therefore, the likelihood of mortality resulting from vehicle collisions is low. The current known range of this species does not overlap with the CPS site and no occurrences have been recorded within 1 mile of the site. (USFWS 2022f). As such, the continued operation of the CPS site during the proposed LR term would have NO EFFECT on the Eastern Massasauga rattlesnake.

State Listed Threatened and Endangered Species

As discussed in Section 3.7.8.2, the IDNR lists six state-listed threatened or endangered species within DeWitt County, Illinois (IDNR 2022d). Aside from the rusty patched bumble bee (discussed in detail above), this includes the northern harrier, Kirtland's snake, spike mussel, American brook lamprey, and monkeyface mussel.

Migratory movements or local flight patterns might result in the occurrence of the northern harrier on the CPS site. Habitat for the species may be located on portions of the CPS site not utilized for operations. A 2020 survey of birds recorded northern harrier in the Clinton Lake area, and the IDNR's Ecological Compliance Assessment Tool (EcoCAT) determined that this species may be in the vicinity of CPS. However, there have been no recorded observations of northern harrier nests either at CPS or in the vicinity of the site. CEG's Avian and Wildlife Management plan provides measures aimed at protecting bird and wildlife at the CPS site. When necessary, consultation with responsible state and federal agencies is conducted to maintain compliance with existing regulations. Adherence to these controls provided in the Plan as well as compliance with laws and regulations, would minimize impacts to these species. Thus, the continued operation of CPS site for the proposed LR term is NOT LIKELY TO AFFECT the northern harrier.

Kirtland's snake has been reported on the CPS property in areas surrounding the station, and the IDNR's EcoCAT determined that this species may be in the vicinity of CPS. A herpetofaunal survey was undertaken in 2019 in areas south of the Salt Creek dam, and five individuals were identified as part of this survey, including a breeding pair. CPS may perform additional monitoring for the presence of Kirtland's snake in the area. These individuals were found in habitat away from the station, south of the dam area; no recorded observations of Kirtland's snake have been made on site. Snakes in general are prone to collision mortality, because they use road surfaces for thermoregulation and their shape, coloration, and low profile make them difficult for automobile drivers to see. However, increased automobile traffic is not anticipated to occur as a result of continued operation of CPS; therefore, the likelihood of mortality resulting from vehicle collisions is low. The continued operation of the CPS site for the proposed LR term is NOT LIKELY TO AFFECT the Kirtland's snake.

While there is potential habitat for the American brook lamprey, spike, and monkeyface mussel to exist in Clinton Lake and surrounding water bodies, no observations have been made of these three state-listed species across aquatic surveys conducted at Clinton Lake. Further, CPS has been operating in compliance with its NPDES permit with no issues. Thus, the continued operation of the CPS site for the proposed LR term would have NO EFFECT on these three aquatic species.

CEG is not aware of any adverse impacts regarding threatened, endangered, and protected species attributable to the site. Maintenance activities necessary to support license renewal would be limited to previously disturbed areas onsite, and no additional land disturbance has been identified for the purpose of LR. In addition, there are no plans to alter station operations during the proposed LR term which would affect threatened, endangered, and protected species.

As discussed in Section 3.7.6, CEG has administrative controls in place at CPS to ensure that operational changes or construction activities are reviewed, and the impacts minimized, through implementation of BMPs. In addition, regulatory programs that the site is subject to, such as those discussed in Chapter 9, further serve to minimize impacts to any threatened, endangered, and protected species.

Migratory Birds

As discussed in Section 3.7.8.4, the following birds of conservation concern have the potential to occur in DeWitt County, Illinois: American golden-plover, black-billed cuckoo, bobolink, cerulean warbler, chimney swift, Henslow's sparrow, Hudsonian godwit, Kentucky warbler, lesser yellowlegs, prothonotary warbler, red-headed woodpecker, ruddy turnstone, rusty blackbird, short-billed dowitcher, upland sandpiper and wood thrush (USFWS 2022a, IPaC). Suitable habitat is potentially present on the CPS site and in the vicinity for all of the species listed above. The American golden-plover, Hudsonian godwit, lesser yellowlegs, ruddy turnstone, rusty blackbird, and short-billed dowitcher occur as migrants through DeWitt County and may utilize stop-over habitat available onsite and in the vicinity. The black billed-cuckoo, bobolink, cerulean warbler, chimney swift, Henslow's sparrow, Kentucky warbler, prothonotary warbler, red-headed woodpecker, upland sandpiper, and wood thrush potentially breed in DeWitt County (USFWS 2022a, IPaC). Avian nests, bird interactions and mortalities documented on the CPS site in the past 5 years have been that of the Canada goose. There was also one incident of an osprey nest on site. CPS has also installed two automated intelligent laser bird repellent units which continuously scans the areas where they are installed and prevent nesting during the breeding season. Thus, the continued operation of the CPS site for the proposed LR term would have NO EFFECT on migratory bird species protected under the MBTA.

Essential Fish Habitat

As stated in Section 3.7.8.5, no EFH is located within the vicinity of CPS, nor were any EFH areas protected from fishing. As HAPCs are derived from EFH, there were also no HAPCs located within the 6-mile vicinity of CPS (NOAA 2022b). Thus, the continued operation of the CPS site for the proposed LR term would have no adverse impacts to EFH.

4.7 Historic and Cultural Resources

4.7.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Continued operations associated with license renewal are expected to have no license renewal-related impacts as no refurbishment or construction activities have been identified; administrative procedure ensures protection of historic properties in the event of excavation activities. The NHPA requires the federal agency to consult with the SHPO and appropriate Native American tribes to determine the potential effects on historic properties and mitigation, if necessary.

4.7.2 Requirement [10 CFR 51.53(c)(3)(ii)(K)]

All applicants shall identify any potentially affected historic or archaeological properties and assess whether any of these properties will be affected by future plant operations and any planned refurbishment activities in accordance with the NHPA.

4.7.3 Background [GEIS Section 4.7.1]

The NRC will identify historic and cultural resources within a defined APE. The license renewal APE is the area that may be impacted by ground-disturbing or other operational activities associated with continued plant operations and maintenance during the license renewal term and/or refurbishment. The APE typically encompasses the nuclear power plant site, its immediate environs, including viewshed, and the transmission lines within this scope of review. The APE may extend beyond the nuclear plant site and transmission lines when these activities may affect historic and cultural resources.

Continued operations during the license renewal term and refurbishment activities at a nuclear power plant can affect historic and cultural resources through (1) ground-disturbing activities associated with plant operations and ongoing maintenance (e.g., construction of new parking lots or building), landscaping, agricultural, or other use of plant property; (2) activities associated with transmission line maintenance (e.g., maintenance of access roads or removal of dangerous trees); and (3) changes to the appearance of nuclear power plants and transmission lines. Licensee renewal environmental reviews have shown that the appearance of nuclear power plants and transmission lines has not changed significantly over time; therefore, additional viewshed impacts to historic and cultural resources are not anticipated.

4.7.4 Analysis

4.7.4.1 Refurbishment Activities

As presented in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license renewal-related refurbishment impacts to historic and cultural resources, and no further analysis is required.

4.7.4.2 Operational Activities

As presented in Section 3.8.5, there have been 17 previous cultural resources surveys within the 13,626-acre CPS property. There are 172 archaeological entries, three cemeteries, and no NRHP eligible cultural resources confirmed within the 13,626-acre CPS property (Table 3.8-2). There are no structures within the CPS property listed on the Illinois Historic Preservation Division's Historic & Architectural Geographic Information System (IHPD-HARGIS) (Table 3.8.4).

As presented in Section 3.8.6, CEG has guidance in place for management of cultural resources ahead of any future ground-disturbing activities at the station. These consist of the Excavation, Trenching and Shoring (SA-AA-117) procedures. These procedures define AC&H resources, and are designed to protect against the impacts to properties, sites, and unanticipated discoveries of AC&H. Therefore, no adverse effects are anticipated to any sites during the CPS proposed LR term.

The area within a 6-mile radius of the CPS site is archaeologically sensitive (Table 3.8-3). The IIAS lists 30 archaeological sites and 10 cemeteries within six miles of the CPS site. There are no NRHP eligible or NRHP listed archaeological sites within six miles of CPS. Adverse impacts, however, would only occur to the sites as a result of soil-intrusive activities. Because CEG has no plans to conduct such soil-intrusive activities at any location outside of the property boundary under a renewed license, no adverse effects to these archaeological sites would occur.

There are no NRHP eligible above ground historic structures within a 6-mile radius of CPS (Table 3.8-4). As there are no modifications to CPS planned during the LR period, there will be no change in the noise and visual impacts to this resource and no adverse effects to the physical or historical integrity of this site is anticipated. There are no NRHP listed properties within six miles of CPS (Table 3.8-4).

No offsite NRHP-listed historic properties will be adversely impacted as a result of continued operations of CPS and there are no plans to alter operations, or disturb additional land for the purpose of LR. In addition, administrative procedural controls are in place for protection of cultural resources ahead of any future ground-disturbing activities at the station.

4.8 Socioeconomics

Impacts to socioeconomics are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to socioeconomics. Therefore, CEG incorporates the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.9 Human Health

Impacts to human health and postulated accidents are evaluated in the GEIS and considered to be generic (the same or similar at all plants), or Category 1 are listed in Section 4.0. CEG conducted a new and significant information review for Category 1 issues and identified no new and significant information related to human health and postulated accidents. Therefore, CEG incorporates the findings of NRC Finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The Category 2 issues for human health are discussed below. The Category 2 issue associated with postulated accidents is addressed in Section 4.15.

4.9.1 Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals, or Cooling Towers that Discharge to a River)

4.9.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals, or that discharge into rivers. Impacts would depend on site-specific characteristics.

4.9.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(G)]

If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river, an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

4.9.1.3 Background [GEIS Section 4.9.1.1.3]

N. fowleri, which is the pathogenic strain of the free-living amoebae *Naegleria* spp., appears to be the most likely microorganism that may pose a public health hazard resulting from nuclear power plant operations. Increased populations of *N. fowleri* may have significant adverse impacts.

Since *Naegleria* concentrations in freshwater can be enhanced by thermal effluents, nuclear power plants that use cooling lakes, canals, ponds, or rivers experiencing low-flow conditions may enhance the populations of naturally occurring thermophilic organisms.

Changes in microbial populations and in the public use of water bodies might occur after the OL is issued and the application for license renewal is filed. Other factors could also change, including the average temperature of the water, which could result from climate change that affected water levels and air temperature. Finally, the long-term presence of a power plant might change the natural dynamics of harmful microorganisms within a body of water.

4.9.1.4 Analysis

Section 3.10.1 describes the thermophilic microorganisms of particular concern at nuclear power plants. Also, Section 3.10.1 presents the information on incidents of infection. Hundreds of millions of visits to swimming venues occur each year in the US that result in 0-8 cases of PAM, the infection from *N. fowleri*, in the US per year. No PAM cases have been reported from exposure to *N. fowleri* in Illinois. (CDC 2022) No waterborne disease cases for untreated recreational waters in Illinois attributed to any of the microorganisms of particular concern in the most recent CDC report (CDC 2019).

As presented in Section 3.10.1, the lake temperatures can reach temperatures favorable to thermophilic organisms. The recreational activities enjoyed at the lake provide exposure to infection routes (e.g., water introduced into nasal passages). The IDPH considered the risk of *N. fowleri* prior to operations and asked for a two-year pre- and post-operational monitoring program for *N. fowleri*. The monitoring program continued through 1990, when it was concluded that no further information was needed and that the risk of *N. fowleri* from Clinton Lake was insignificant relative to other public health risks. (67 FR 16461)

When an increase in the NPDES discharge limit was proposed to increase the maximum daily average discharge temperature to be raised from 99°F to 110.7°F, IDPH was given a presentation on the modeled lake temperatures that would result. The higher NPDES permit limits were granted in 1992 and continue as the current limits. (67 FR 16461)

NRC also considered the human health risk of the thermal discharge in 2002 for a CPS power uprate. NRC concluded that the very small risk to human health from the thermal discharge would not be significantly increased by the power uprate. (67 FR 16461)

CPS and recreational use of Clinton Lake have co-existed for nearly 40 years. CPS's thermal discharge is not known by CEG to have contributed to cases of waterborne disease.

CPS operates two banks of MDCTs during summer months to lower the temperature of the discharge. The cooling towers were first placed into operation in 2018 and 2019. The cooling towers are located on the station-end of the discharge flume, thus away from the lake itself and the Clinton Lake State Recreational Area (as shown in Figures 3.1-1 and 3.1-5). The water vapor emissions from the cooling towers have the potential to include the bacteria *Legionella*. The water that circulates through the cooling towers is treated prior to its introduction into station systems with biocides and scale and corrosion inhibitors to maintain adequate disinfection and prevent biofilm and scale formation. The cooling towers are approximately 20 feet in height which provide a low profile for atmospheric dispersion.

CEG concludes that the microbiological hazard to the public attributable to the thermal discharge from continued operation of CPS's cooling water system would be SMALL based on (1) the low and very low incidence of human infections from thermophilic microorganisms of particular concern as related to recreational use of untreated waters and (2) that operation during this license term is not known to be attributed to cases of waterborne disease.

CEG also concludes that the microbiological hazard to the public attributable to continued operation of CPS's cooling water system's two cooling towers would be SMALL because (1) the cooling towers are not accessible to the public, (2) the circulating water is treated with biocides, (3) the higher risk of *Legionella* exposure is presented by indoor or confined spaces.

Regulatory Guide 4.2 for LR applicants directs the applicant to consult with the state public health department—in this case, IDPH, regarding concerns about the potential for waterborne disease outbreaks associated with LR (NRC 2013b). Correspondence is included in Attachment E. The IDPH responded on October 19, 2023, that since 2014 there have been no reports for DeWitt County of outbreaks including Legionnaires' Disease and cases of primary amebic meningoencephalitis caused by Naegleria fowleri. This information supports the conclusion that the microbiological hazard to the public attributable to continued operation of CPS would be SMALL.

4.9.2 Electric Shock Hazards

4.9.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Electrical shock potential is of small significance for transmission lines that are operated in adherence with the National Electrical Safety Code (NESC). Without a review of conformance with NESC criteria of each nuclear power plant's in-scope transmission lines, it is not possible to determine the significance of the electrical shock potential.

4.9.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(H)]

If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

4.9.2.3 Background [GEIS Section 4.9.1.1.5]

Design criteria for nuclear power plants that limit hazards from steady-state currents are based on the NESC, adherence to which requires that utility companies design transmission lines so that the short-circuit current to ground produced from the largest anticipated vehicle or object is limited to less than 5-mA. With respect to shock safety issues and license renewal, three points must be made. First, in the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed. Second, some plants that received operating licenses with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects. Third, since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for a reevaluation of this issue. The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear plants, is of SMALL significance for transmission lines that are operated in adherence with the NESC. Without a review of the conformance of each nuclear plant's transmission lines, within this scope of review with NESC criteria, it is not possible to determine the significance of the electrical shock potential generically.

4.9.2.4 Analysis

As discussed in Section 3.10.2, the in-scope transmission lines are within fenced/barricaded areas of the CPS developed area and also within the owner-controlled area of CPS. As, such, the lines do not present an electric shock risk to the public. Work on and near the lines between the power block and the 345-kV switchyard is governed by station and fleet procedures and CPS's comprehensive health and safety program. The 138-kV line to the ERAT is owned and operated by the transmission company, Ameren. Work on these lines would be by Ameren qualified staff. Work on CPS's equipment connected to the Ameren line and work beneath the line is governed by station procedures and CPS's comprehensive health and safety program.

As discussed in Section 3.10.2, the 138-kV transmission line is in compliance with NESC because the phase to ground voltage of this line would be less than the 5-mA steady-state current due to electrostatic effects threshold of the NESC clearance standard. Ameren has surveillance and maintenance procedures to provide assurance that design ground clearances are maintained. These procedures include routine aerial inspections that check for encroachments, broken conductors, broken or leaning structures, and signs of trees burning. Ground inspections include examination for clearance at questionable locations, integrity of structures, and surveillance for dead or diseased trees that might fall on the transmission lines. Any concerns noted during an inspection are brought to the attention of the appropriate organization(s) for corrective action.

Given these conditions, CEG concludes that human health impact from electric shock hazards during the proposed LR term would be SMALL.

4.10 Environmental Justice

The NRC identified only one issue for environmental justice. This is a Category 2 issue and is discussed below, providing background and the analysis identified as pertaining to the proposed LR term.

4.10.1 Minority and Low-Income Populations

4.10.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Impacts to minority and low-income populations and subsistence consumption resulting from continued operations and refurbishment associated with license renewal will be addressed in plant-specific reviews. See NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040).

4.10.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(N)]

Applicants shall provide information on the general demographic composition of minority and low-income populations and communities (by race and ethnicity) residing in the immediate vicinity of the plant that could be affected by the renewal of the plant's operating license, including any planned refurbishment activities, and ongoing and future plant operations.

4.10.1.3 Background [GEIS Section 4.10.1]

Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Minority and low-income populations are subsets of the general public residing around the site and all are exposed to the same risks and hazards generated from operating a nuclear power plant.

Continued reactor operations and other activities associated with license renewal could have an impact on air, land, water, and ecological resources in the region around each nuclear power plant site, which might create human health and environmental effects on the general population. Depending on the proximity of minority and low-income populations in relation to each nuclear plant, the environmental impacts of license renewal could have a disproportionate effect on these populations.

The location and significance of environmental impacts may affect population groups that are particularly sensitive because of their resource dependencies or practices (e.g., subsistence agriculture, hunting, or fishing) that reflect the traditional or cultural practices of minority and low-income populations. The analysis of special pathway receptors can be an important part of the identification of resource dependencies or practices. Special pathways take into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the power plant sites in order to assess the risk of radiological exposure through subsistence consumption of fish, native vegetation, surface water, sediment, and local produce; the absorption of contaminants in sediments through the skin; and the inhalation of airborne particulates.

4.10.1.4 Analysis

4.10.1.4.1 Refurbishment Activities

As presented in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license-renewal-related refurbishment impacts to minority and low-income populations, and no further analysis is applicable.

4.10.1.4.2 Operational Activities

The consideration of environmental justice is required to assure that federal programs and activities will not have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. CPS's analyses of the Category 2 issues defined in 10 CFR 51.53(c)(3)(ii) determined that environmental impacts from the continued operation of CPS during the LR term would either be SMALL or non-adverse. Therefore, high, or adverse impacts to the general human population would not occur.

As described in Section 3.10, CPS maintains a REMP. With this program, CPS monitors important radiological pathways and considers potential radiation exposure to plant and animal life in the environment surrounding CPS. The results of the program indicate CPS has created no adverse environmental effects or health hazards that could affect subsistence populations.

Section 3.11.2 identifies the locations of minority and low-income populations as defined by NRR Office Instruction LIC-203 (NRC 2020b). Section 3.11.3 describes the search for subsistence populations near CPS, of which none were found. The figures accompanying

Section 3.11.2 show the locations of minority and low-income populations within a 50-mile radius of CPS. None of those locations, when considered in the context of impact pathways described in this chapter, are expected to be disproportionately impacted.

Therefore, CEG concludes that no disproportionately high and adverse impacts or effects on members of the public, including minority, low-income, or subsistence populations, are anticipated during the proposed LR term.

4.11 Waste Management

Impacts to waste management are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to waste management. Therefore, CEG incorporates NRC Finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.12 Cumulative Impacts

4.12.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Cumulative impacts of continued operations and refurbishment associated with license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource.

4.12.2 Requirement [10 CFR 51.53(c)(3)(ii)(O)]

Applicants shall provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear plant that may result in a cumulative effect.

4.12.3 Background [GEIS Section 4.13]

Actions to be considered in cumulative impact analyses include new and continuing activities, such as license renewal, which are conducted, regulated, or approved by a federal agency. The cumulative impacts analysis takes into account all actions, however minor since impacts from individually minor actions may be significant when considered collectively over time. The goal of the analysis is to identify potentially significant impacts to improve decisions and move toward more sustainable development.

For some resource areas (e.g., water and aquatic resources), the contributions of ongoing actions within a region to cumulative impacts are regulated and monitored through a permitting process (e.g., NPDES) under state or federal authority. In these cases, it may be assumed that cumulative impacts are managed as long as these actions (facilities) are in compliance with their respective permits.

4.12.3.1 Analysis

Cumulative impacts analysis involves determining if there is an overlapping or compounding of the anticipated impacts of the continued operation of CPS during the proposed LR term with past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such actions.

CEG considered potential cumulative impacts during the license renewal period in its environmental analysis associated with the resources discussed in the following sections. For the purposes of this analysis, past actions are those related to the resources at the time of station licensing and construction, present actions are those related to the resources at the time of current operation of the power station, and future actions are considered to be those that are reasonably foreseeable through the end of station operation, which would include the 20-year license renewal term. These criteria are in line with Regulatory Guide 4.2, Supplement 1, Rev. 1 (NRC 2013b). The geographic area over which past, present, and future actions would occur is dependent on the type of action considered and is described below for each impact area. The effects of past actions are already reflected in the description of the affected environment in Chapter 3.

The impacts of the proposed action are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor, but collectively significant, actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

As indicated in Section 3.1.4, no major changes to CPS operations or plans for future expansion of plant infrastructure during the LR term, are anticipated. Expansion of storage capacity for SNF may be needed to accommodate SNF for the LR term The possible need to expand the size of the ISFSI, and the scope of any such expansion, cannot be determined at this time, as it would depend on the status of the DOE's future performance of its obligation to accept SNF or the availability of other interim storage options. Consequently, the possibility of such expansion is currently uncertain. If expansion is required, construction would occur on previously disturbed land near the existing ISFSI, and therefore would not be expected to have any significant environmental impacts. The site selection process would consider regulations for, and commitments to, the protection of protected species, wetlands, and cultural resources.

As described in Section 3.1.4, one (non-CPS) project was identified in the region of CPS. A Wind Energy System Facility, Alta Farms Wind Project II, is currently under construction in DeWitt County approximately nine miles west of CPS. The project covers approximately 12,000 acres. The project expects to create $44 million in local tax revenue over the next 25 years. The completion date is unknown. (EGP 2022, WP 2023) There are no NRC-licensed operating nuclear power plants, fuel cycle facilities, or radiological waste treatment and disposal facilities within the 50-mile region of CPS (NRC 2023).

4.12.4 Land Use and Visual Resources

As discussed in the GEIS, reactor operations have a SMALL impact on the land use (NRC 2013a). As described in Section 3.1.4, there are currently no planned projects for the CPS site that would be expected to require a change in land use. As discussed in Section 3.1.4, the Alta Farms Wind Project II is the only project identified near CPS that may be expected to require land use changes. However, because there are no land use changes expected for CPS there is no contribution to the cumulative impacts on land use. Therefore, the cumulative land use impact would be SMALL.

The CPS vicinity is described in Section 3.2.3, CPS is located on the irregular U-shaped bend of Clinton Lake and within several townships of DeWitt County, Illinois. The surrounding area is a mixture of agricultural land, deciduous forest, rural residential, towns and small communities.

As stated in Section 3.2.3, the continued use of existing structures associated with CPS would not alter their visual impact. The nature of the projects (unrelated to the station) listed in Section 3.1.4 would not be expected to combine with the visual impacts of CPS. Because the visual impacts due to CPS are SMALL, not expected to change, and external projects are not expected to contribute to CPS's visual impacts, the cumulative visual impacts are expected to be SMALL.

4.12.5 Air Quality and Noise

4.12.5.1 Air Quality

As discussed in the GEIS, reactor operations have a SMALL impact on air quality (NRC 2013a). Therefore, CPS operations have a SMALL impact on the air quality. Section 3.3.3 presents the regional air quality and CPS's air emission sources. All of the counties in the CPS 62-mile region are in attainment for NAAQS. Three of the counties are maintenance areas for SO_2 (1971) and SO_2 (2010).

CPS air pollutant emissions are minimal and stem from intermittent use, maintenance and testing of diesel generators. The NRC generically determined that the impact to air quality from the continued operation of nuclear facilities is anticipated to be SMALL (NRC 2013a). The pending present actions and anticipated future actions along with continued operation of CPS is expected to have a SMALL cumulative air quality impact.

4.12.5.2 Climate Change

Climate change can impact air quality as a result of changes in meteorological conditions. Air pollutant concentrations are sensitive to winds, temperature, humidity, and precipitation. Ozone levels have been found to be particularly sensitive to climate change influences. Sunshine, high temperatures and air stagnation are favorable meteorological conditions leading to higher levels of ozone. Although surface temperatures are expected to increase, ozone levels will not necessarily increase because ozone formation is also dependent on the relative number of precursors available. The combination of higher temperatures, stagnant air masses, sunlight, and emissions of precursors may make it difficult to meet ozone NAAQS. States, however, must continue to comply with the CAA and ensure air quality standards are met. (NRC 2015) Because the fuel source for CPS does not produce CO_2 emissions or other GHG emissions, the continued operation of CPS would avoid millions of tons of greenhouse gases from a fossil fuel-fired alternative such as the NGCC presented in Chapter 7.

Given that climate change trends in air temperature and precipitation are increasing but continued operation would contribute only small emissions of GHG from minor air emission sources, the cumulative impact on climate change from present and future actions would be SMALL. Moreover, continued operation of CPS avoids millions of tons of CO_2 from alternative fossil-fuel generation, positively impacting the climate change factor of carbon dioxide concentrations.

4.12.5.3 Noise

As discussed in the GEIS, reactor operations have a SMALL noise impact (NRC 2013a). As stated in Section 3.1.4, there are no projects currently underway or scheduled for the near future at CPS. The non-CPS project described in Section 3.1.4 is a construction project that would be expected to be SMALL and limited in duration. Because the noise impacts from continued station operations over the license renewal term would be SMALL and the expected noise impacts from the project listed in Section 3.1.4 would be SMALL and limited in duration, cumulative noise impacts would be SMALL.

4.12.6 Geology and Soils

As discussed in the GEIS, reactor operations have a SMALL impact to geology and soils (NRC 2013a). Impacts to geology and soils at the site could result from ground-disturbing activities and stormwater runoff. As noted in Section 2.3, CEG has no plans to conduct license-renewal-related refurbishment or replacement activities. As indicated in Section 3.1.4, no major changes to CPS operations or plans for future expansion of station infrastructure during the LR term, are anticipated. Any ground-disturbing activities onsite during the proposed LR term would be governed by a stormwater construction permit and/or the SWPPP. Given there are no planned changes to the CPS site and surrounding area, any ground disturbances would be subject to NPDES stormwater permitting and applicable BMPs, the cumulative land use impact would be SMALL.

4.12.7 Water Resources

4.12.7.1 Surface Water

As detailed in Section 2.2.3.1, CPS operational cooling modes of condenser cooling include the use of cooling towers for part of the year. Service water for CPS is obtained from Clinton Lake. According to the GEIS, surface water use conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems. However, surface water use conflicts could occur with nuclear power plants that rely on cooling ponds or cooling towers using makeup water from a river. (NRC 2013a) As discussed in Section 4.5.1, CPS does not withdraw service and makeup water from a river. Therefore, the surface water resources impacts are SMALL.

Any surface water withdraw modifications would be processed under a NPDES permit issued by the IEPA, and water use impacts would be considered by IEPA prior to issuance of the permit. There are no station operations or modifications planned for the proposed LR term that would alter current patterns at the intake and discharge structures. The Alta Farms Wind Project II would not be expected to contribute to surface water conflicts due to the nature of wind farms. Because CPS is expected to continue its compliance with the NPDES permit, CPS would have only a small contribution to the surface water use cumulative impact.

As for surface water quality cumulative impacts, CPS complies (see Chapter 9) with its NPDES discharge limits, and the discharge rapidly mixes with the Salt Creek arm of Clinton Lake. As discussed in Section 3.6.4.1, the water quality at Clinton Lake and several streams near CPS are impaired; however, CPS operations do not contribute to these impairments. Therefore, the cumulative impact to surface water quality would be SMALL. Given CPS compliance with its NPDES permit and compliance with stormwater permits and regulations, CPS would have only a small contribution to the surface water quality cumulative impact.

4.12.7.2 Groundwater

As presented in Section 3.6.3.2, CPS does not use groundwater for the facility. It is not anticipated that groundwater withdrawal would be required during the LR term. CPS would continue to maintain and implement its site-specific spill prevention plans to prevent spills that would contaminate soils, groundwater, and surface water during the proposed LR term. Therefore, the cumulative impact to groundwater resources would be SMALL.

4.12.7.3 Climate Change

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users (NRC 2013a). In Illinois, temperature and precipitation have been increasing in the past few decades. Spring rainfall and annual precipitation are likely to continue to increase and severe rainstorms are likely to intensify increasing the risk of flooding. The availability of water is expected to reduce due to warmer temperatures, increased evaporation, and increased transpiration reducing average river flows. (EPA 2016, USCRT 2022)

As previously mentioned, CPS operations do not consume significant amounts of surface water or need groundwater withdrawals. There are no anticipated or reasonably foreseeable changes in surface water withdrawal rates or groundwater withdrawals.

Warmer water and higher air temperatures can reduce the efficiency of thermal power plant cooling technologies. In addition, discharge-permit conditions may limit operations for some power plants as water temperatures rise (NRC 2013a). CPS has recently added cooling towers to add operational cooling modes to the system to reduce the thermal impacts of water discharges. As such, although no changes are reasonably foreseeable, if any changes were to occur, CPS would continue to operate within permitted conditions.

Given that the continued operation would have a small impact on water resources and its continued operation would avoid millions of tons of CO_2 from alternative fossil-fuel generation, the continued operation of CPS could be viewed as a net beneficial contribution to climate change impacts.

4.12.8 Ecological Resources

The impacts of the station on ecological resources are presented in Section 4.6.

4.12.8.1 Terrestrial

The impacts on terrestrial species during the proposed LR period are described as SMALL in Section 4.6.5.4. The continued operation of CPS is governed by regulations, CPS procedures and plans. As discussed in Section 9.6, CEG has administrative controls in place at CPS to ensure that operational changes or construction activities are reviewed, and the impacts minimized through implementation of BMPs, permit modifications, or acquisition of new permits as needed.

Successful application of the regulations, procedures, plans, and administrative controls would result in the identification and avoidance of important terrestrial habitats. In addition, the application of BMPs to minimize the area affected; to control fugitive dust, runoff, and erosion from project sites; to reduce the spread of invasive nonnative plant species; and to reduce disturbance of wildlife in adjacent habitats could greatly reduce the impacts of continued operations (NRC 2013a).

Regulatory programs that the site is currently subject to such as stormwater management, spill prevention, dredging, and herbicide usage further serve to minimize impacts to terrestrial resources. With continued application of these programs and procedures, the land-based impacts would largely be confined to CPS property and would have minimal opportunity to contribute to cumulative impacts.

As discussed in Sections 3.7.8.1 and 4.6.6.4, habitat for federally and state listed terrestrial species does occur on the CPS site. However, as stated in Section 4.6.6.4, impacts to Federally listed and state listed threatened and endangered species range from NO EFFECT to MAY

AFFECT BUT IS NOT LIKELY TO ADVERSELY AFFECT. Adherence to regulatory and permit requirements to avoid take of protected species and CEG administrative controls such as those regarding response to avian collisions with transmission lines would minimize or avoid impact to these species. CEG is not aware of any adverse impacts regarding threatened, endangered, and protected species attributable to the site.

As discussed in Section 4.6.5.4, maintenance activities necessary to support license renewal likely would be limited to previously disturbed areas onsite during the proposed LR term rather than within any other habitat on the site. The Alta Farms Wind Project II would be expected to coordinate with the state to mitigate the project's impacts on wildlife. Therefore, cumulative impacts on protected species would be SMALL. Overall, the cumulative impacts to terrestrial ecological resources are anticipated to be SMALL.

4.12.8.2 Aquatic

Aquatic resource impacts during the proposed LR period were concluded to be SMALL in Sections 4.6.1.4 and Section 4.6.2.4. The aquatic ecological communities could be impacted through surface water discharges that are governed by CPS's NPDES permit. In addition, aquatic ecological communities could be impacted by impingement and entrainment of species in CPS surface water intake. Impingement and entrainment impacts are addressed through CWA 316(b) compliance implemented through the NPDES system. Ongoing studies performed at CPS would ensure that CPS continues to utilize the best technology available to minimize entrainment and impingement to the fullest extent practicable to maintain compliance with the NPDES permit. Continued compliance with NPDES permit conditions during the proposed LR period would ensure that CPS's direct and indirect impacts to aquatic ecological communities are minimized.

As stated in Section 3.7.8.5, no EFH is located within the vicinity of CPS, nor were any EFH areas protected from fishing. As HAPCs are derived from EFH, there were also no HAPCs located within the 6-mile vicinity of CPS.

As a wind farm, the Alta Farms Wind Project II would not be expected to contribute to cumulative impacts on aquatic wildlife. Therefore, the cumulative impacts on aquatic ecological communities would be SMALL.

4.12.8.3 Climate Change

Climate change can affect ecological resources by causing shifts in species' ranges and migratory corridors. For rivers and streams temperature increases can affect aquatic species. (NRC 2013a) Temperatures in the Great Lakes region have been increasing over the past several decades. Annual precipitation has also increased. (USCRT 2022) The CEG adherence to regulatory and permit requirements to avoid take of protected species and CEG administrative controls such as those regarding response to avian collisions with transmission lines would minimize or avoid impact to species impacted by changing aquatic or terrestrial habitat. No changes in the temperature of CPS's existing thermal discharge are expected with no planned operational changes during the proposed LR period. Therefore, the CPS contribution to cumulative impacts to ecological communities from climate change are anticipated to be SMALL during the LR period.

4.12.9 Historic and Cultural Resources

As presented in Section 2.3, there are no refurbishment activities or other construction activities currently planned to support LR operations. Therefore, the LR consists of an administrative action relative to historic and cultural resources. As presented in Section 4.7.4.2, CEG has administrative controls in place for management of cultural resources ahead of any future ground-disturbing activities at the station. As described in Section 3.8.6, CPS has a procedure specific to ground-disturbing activities that requires disruptive activity at the site be halted and CPS staff be notified if any archeological areas are identified during construction or other land-disturbing activities. Therefore, no adverse effects are anticipated to these sites during the proposed LR term. Section 4.7.4.2 also presented the potential for continued operation of CPS to affect cultural resources in the surrounding area and concluded that no adverse effects to the physical or historical integrity of these sites are anticipated. Therefore, CPS is not anticipated to contribute cumulative impacts to historic and cultural resources.

4.12.10 Socioeconomics

As discussed in Section 2.5, the proposed LR does not include plans to add permanent workers, so the SMALL adverse impacts that are the result of workers' impact on community services, education, and infrastructure including transportation would not change. As discussed in Section 3.9.5, CEG's annual property tax payments are expected to remain relatively constant throughout the license renewal term. The economic contributions of the station's workers would remain the same. Thus, significant beneficial socioeconomic impacts would also continue during the proposed LR term.

4.12.11 Human Health

Radiological dose limits for protection of the public and workers have been developed by the EPA and the NRC to address the cumulative impacts of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR 20 and 40 CFR 190. For this analysis, the region of influence is the surrounding 50-mile region.

As presented in Section 3.10.3, CEG prepares AREORs and ARERRs. The reports for 2018−2022 indicate that doses to members of the public were in accordance with NRC and EPA radiation protection standards. The 3-year (2017-2019) average annual occupational dose TEDE was 0.102 rem. The annual TEDE limit is five rems [10 CFR 20.1201(a)(1)].

Because no changes to the operation of CPS are expected, operating CPS for an additional 20-year period would not cause an increase in annual radioactive effluent releases. There are no NRC-licensed operating nuclear power plants, fuel cycle facilities, or radiological waste treatment and disposal facilities within the 50-mile region of CPS (NRC 2023). Therefore, there are no cumulative radiological impacts from CPS operations.

As for non-radiological human health impacts, as pointed out in Section 4.9.1.4, CPS operations occur with temperatures reaching the temperatures optimal to grow pathogens. However, for nearly 40 years of operation and the recreational use of Clinton Lake, CPS's thermal discharge has not been identified as contributing to cases of waterborne disease. Therefore, CPS's thermal discharge is unlikely to pose a risk to human health or add to any cumulative impacts.

As described in Section 2.2.5.5, CPS maintains safety-specific policies for all work conducted at electrical transmission locations. As presented in Sections 3.10.2 and 4.9.2.4, compliance with NESC and CPS procedures minimize occupational risk from electrical shock hazards. Section 4.9.2.4 concluded that the human health impact from electric shock hazards during the proposed LR term would be SMALL. Therefore, cumulative human health impacts from electric shock hazards are not expected.

4.12.12 Waste Management

As presented in Section 2.2.6, the comprehensive regulatory controls in place for management of radiological waste and CEG's compliance with these regulations and use of only licensed treatment and disposal facilities would allow the impacts to remain SMALL during the proposed LR term. The NRC oversees the licensing of radiological waste treatment and disposal facilities. There are four facilities providing LLRW disposal services in the United States (NRC 2020c). As presented in Section 3.10.3, CPS's annual reports for 2012−2022 indicate that radiological doses to members of the public were well within the federally required limits. There are no other operating nuclear power plants, fuel cycle facilities, or radiological waste treatment and disposal facilities within the 50-mile region of CPS (NRC 2023).

As described in Section 2.2.7, CPS has programs in place to manage its hazardous and nonhazardous waste streams. CPS also ensures that only approved facilities are used to manage and dispose of hazardous, nonhazardous, and recyclable waste. Continuation of existing systems and procedures to ensure proper storage and disposal of nonradioactive waste during the proposed LR term would allow the impacts to be SMALL.

Any other commercial operation within the 50-mile region of CPS is also required to comply with appropriate EPA and state requirements for the management of wastes. Thus, the cumulative waste management impact would be SMALL.

4.13 <u>Impacts Common to all Alternatives: Uranium Fuel Cycle</u>

Impacts to the uranium fuel cycle are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to uranium fuel cycle. Therefore, CEG incorporates the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.14 Termination of Nuclear Power Plant Operations and Decommissioning

Impacts to the termination of nuclear power plant operations and decommissioning are evaluated in the GEIS and are considered to be generic (the same or similar at all plants), or Category 1. CEG conducted a new and significant information review and identified no new and significant information related to termination of nuclear power plant operations and decommissioning. Therefore, CEG incorporated the NRC finding from 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

4.15 Severe Accident Mitigation Alternatives (SAMA) Analysis

Section 4.15 summarizes an analysis of alternative ways to mitigate the impacts of severe accidents at CPS. Attachment F provides a detailed description of the severe accident mitigation alternatives (SAMA) analysis.

NRC defines "design basis" accidents as postulated accidents during which, should they occur, the plant design and construction should be robust enough to ensure that the plant can withstand normal and abnormal transients (e.g., rapid changes in reactor power) without undue risk to the health and safety of the public. "Severe accidents" (i.e., beyond design basis) are defined as postulated accidents that could result in substantial damage to the reactor core, whether or not there are serious off-site consequences (NRC 2013a).

4.15.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

"*. . .* The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives *. . .*" 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 76

4.15.2 Requirement [10 CFR 51.53(c)(3)(ii)(L)]

The environmental report must contain a consideration of alternatives to mitigate severe accidents "*. . .* if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environment assessment . . . " 10 CFR 51.53(c)(3)(ii)(L)

4.15.3 Analysis

In the 2013 GEIS, the NRC reexamined the information from its 1996 GEIS, Revision 0, and concluded that the unmitigated environmental impacts from severe accidents still meet Category

1 criteria, and that consideration of SAMA remains a Category 2 issue (NRC 2013a). Site-specific information to be presented in the license renewal environmental report includes: (1) potential SAMAs; (2) benefits, costs, and net value of implementing potential SAMAs; and (3) sensitivity of analysis to changes in key underlying assumptions.

CEG maintains a probabilistic risk assessment (PRA) model to evaluate the most significant risks of radiological release from CPS fuel into the reactor and from the reactor into the containment structure. The original CPS Individual Plant Examination was submitted to the NRC in 1992 (IP 1992) and the Individual Plant Examination of External Events was submitted in 1995 (IP 1995). In order to maintain fidelity with the operating plant, to reflect the latest PRA technology, and to support application specific efforts, the PRA model was updated numerous times between 1992 and 2023. The most recent model update that was complete at the time the SAMA analysis was performed was finalized in 2020 to address Findings & Observations (F&Os) from the 2009 Full Power Internal Events Peer Review and 2018 Fire PRA Peer Review.

For the SAMA analysis, CEG used the CPS PRA model output as input to an NRC-approved consequence assessment code that calculates economic costs and dose to the public from hypothesized releases from the containment to the environment. This Level 3 PRA model uses the Windows MELCOR Accident Consequences Code System (WinMACCS). WinMACCS requires certain site-specific information, such as economic data, population estimates, and meteorological data, which are described in more detail in Attachment F. Meteorological data was obtained from the CPS meteorological program. Economic data and population inputs were developed using data in the SecPop code (NRC 2019a) for each of the 20 counties surrounding the plant, to a distance of 50 miles. Then, using the NRC regulatory analysis techniques documented in NUREG/BR-0184 (NRC 1997), CEG calculated the monetary value of the unmitigated CPS severe accident risk. The result represents the monetary value of the baseline risk of dose to the public and workers, offsite and onsite economic costs, and replacement power cost. This value was used as a cost/benefit-screening tool for potential SAMAs; a SAMA whose cost of implementation exceeded the baseline cost-risk value was rejected as being not cost-beneficial for CPS.

CEG used industry, NRC, and CPS-specific information to create a list of 22 SAMAs for consideration. CEG analyzed this list to screen out any SAMAs that (1) would not apply to the CPS design, (2) had already been implemented at CPS, or (3) would achieve results that CEG had already achieved at CPS by other means. None of the SAMAs were screened out based on these criteria. Therefore, CEG used a combination of industry and plant-specific estimates of the cost for implementing each of the 22 SAMAs and used the baseline cost-risk value to screen out SAMAs that would not be cost-beneficial to implement. None of the SAMAs were screened out based on this criterion.

For each of the un-screened SAMAs, CEG calculated the cost-risk value for the plant configuration in which the SAMA was implemented. The difference between the baseline cost-risk value and the cost-risk value of the plant configuration in which the SAMA was implemented was defined as the "averted cost-risk." The averted cost-risk represents the monetary value of the risk reduction (the benefit) associated with implementing the SAMA. CEG then compared the benefit of each unscreened SAMA to its cost of implementation; SAMAs with benefits that exceeded their implementation costs were defined as "potentially cost-beneficial."

CEG performed additional sensitivity analyses to evaluate how the SAMA analysis would change if certain key parameters were changed. The results of the sensitivity analyses are discussed in Attachment F.

Based on the results of this SAMA analysis, CEG identified 11 SAMAs for CPS that have the potential to reduce plant risk and be cost-beneficial at the 95th percentile. None are related to managing the effects of plant aging during the PEO. The potentially cost beneficial SAMAs have been submitted to the CPS Plant Health Committee, which will consider them for implementation in accordance with an established plant procedural process.

5.0 NEW AND SIGNIFICANT INFORMATION

While NRC regulations do not require an initial LR applicant's ER to contain analyses of the impacts of those Category 1 environmental issues that have been generically resolved [10 CFR 51.53(c)(3)(i)], the regulations do require that an applicant identify any new and significant information of which the applicant is aware [10 CFR 51.53(c)(3)(iv)].

5.1 New and Significant Information Discussion

The NRC provides guidance on new and significant information in Regulatory Guide 4.2, Supplement 1, Revision 1. In this guidance, new and significant information is defined as follows:

> (1) Information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Plants," in Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," to Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," of 10 CFR Part 51; or
>
> (2) Information not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1.
>
> (3) Further, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity and/or scope (context) not previously recognized. (NRC 2013b)

Based on available guidance and the definitions of SMALL, MODERATE, and LARGE impacts provided by NRC in 10 CFR Part 51, Appendix B, Table B-1, Footnote 3, CEG considers that any new information regarding Category 1 issues with MODERATE or LARGE impacts would be significant. Section 4.0.2 presents the NRC's definitions of SMALL, MODERATE, and LARGE.

5.2 CEG's New and Significant Information Review Process

The new and significant information assessment described below meets or addresses regulatory guidance provided above.

CEG's process is collectively carried out through its ongoing environmental planning, assessment, monitoring, and compliance activities performed by corporate and CPS management and staff. This team has collective knowledge of the CPS site, licensing and permitting, environmental and regulatory issues, the NEPA process, and other nuclear industry activities which could potentially provide new and significant information.

CEG's new and significant information review included establishment of applicable and non-applicable Category 1 issues through:

- Review of the GEIS for its Category 1 discussions,
- Identification and review of past or potential modifications to CPS, including environmental impacts; and
- Identification and assessment of equipment and operations with the potential to result in changes in emissions, releases, discharge points, land use, noise levels, etc., considering environmental reviews since initial licensing, and those anticipated during the proposed LR term.

CEG has applied an investigative process for purposely seeking new information related to the Category 1 environmental issues through:

- Environmental review team discussions with CEG and CPS subject matter experts on the Category 1 issues as they relate to the station;
- Review of permits and reference materials related to environmental issues at the station, the environmental resource areas related to Category 1 issues, and information collected for regulatory compliance status;
- Review of recent publicly available information, or information held by CEG, particularly data or reports from the past 5 years, related to the resource area and each applicable Category 1 impact issue, as summarized in the appropriate section of the license renewal ER in Chapter 3.0, Affected Environment;
- Review of environmental monitoring and reporting required by regulations related to the CPS site and operations;
- Review of CEG environmental programs and procedures related to the CPS site and operations;
- Review of correspondence and permitting documentation related to oversight of CPS facilities and operations by state and federal regulatory agencies (activities that would bring significant issues to the station's attention), to identify site-specific environmental concerns; and
- Review of other plants' previous initial and subsequent LRAs for issues relevant to this CPS LR ER.

In addition, CEG is made aware and stays abreast of new and emerging environmental issues and concerns on an ongoing basis through:

- Review of nuclear industry publications, operational experience, and participation in nuclear industry organizations;

- Contact with state and federal resource agencies with regulatory jurisdiction over environmental regulation; and
- Development and periodic review of regulatory guidance procedures that address ongoing and emergent issues.

Information resulting from the information-seeking process was assessed to determine if it is new, and/or significant, applying the following considerations:

- Was the information included in or available for the GEIS analysis of the Category 1 issue?
- Does the information identify an environmental issue not generically considered in the GEIS, and consequently, not codified in 10 CFR 51, Appendix B, Table B-1?
- Does the information present a seriously different picture of the environmental consequences of the action than previously considered, leading to an impact finding different from that included in the GEIS or codified in regulation?
- Does the information involve a new activity or aspect associated with the nuclear power station that can act upon the environment in a manner or an intensity (MODERATE or LARGE) and/or scope (context) not previously recognized?

5.3 CEG’s New and Significant Information Review Results

As a result of this review, CEG is aware of no new and significant information regarding the environmental impacts of LR associated with CPS. The findings in NUREG-1437, Revision 1, for the applicable Category 1 issues are therefore incorporated by reference. The results of the new and significant information review for the severe accident consequences issue are presented in Section 4.15.

6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

6.1 License Renewal Impacts

Chapter 4 incorporates by reference NRC findings for the 54 Category 1 issues that apply to CPS, all of which have SMALL environmental impacts. In addition, Chapter 4 presents site-specific analyses of the 17 Category 2 issues, 11 of which are applicable to CPS. Table 6.1-1 identifies the environmental impacts that renewal of the CPS OL would have on resources associated with applicable Category 2 issues.

CEG has reviewed the environmental impacts of renewing the CPS OL and concluded that further mitigation measures beyond those presented in Section 6.2 and listed in Table 6.1-1 of this ER to avoid, reduce the severity of, or eliminate adverse impacts are not warranted. This ER documents the basis for CEG's conclusion.

Table 6.1-1 Environmental Impacts Related to License Renewal at CPS (Sheet 1 of 5)

Resource Issue	ER Section	Environmental Impact
Groundwater Resources		
Radionuclides Released to Groundwater [10 CFR 51.53(c)(3)(ii)(P)]	4.5.5	SMALL impact. Water for station use continues to be processed and monitored in compliance with licensing and permitting resulting in SMALL impacts and do not warrant additional mitigation measures.
Terrestrial Resources		
Effects on Terrestrial Resources (Non-Cooling System Impacts) [10 CFR 51.53(c)(3)(ii)(E)]	4.6.5	SMALL impact. No refurbishment or other LR-related construction activities have been identified; adequate management programs and regulatory controls are in place to prevent impacts outside of previously disturbed areas during the LR period resulting in SMALL impacts on terrestrial resources.

Table 6.1-1 Environmental Impacts Related to License Renewal at CPS (Sheet 2 of 5)

Resource Issue	ER Section	Environmental Impact
Aquatic Resources		
Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds) [10 CFR 51.53(c)(3)(ii)(B)]	4.6.1	SMALL impact. In the 2021 NDPES permit, IEPA designated the CPS cooling water intake as best available technology for reducing impacts of impingement and entrainment. Impacts from impingement and entrainment of aquatic organisms during the proposed operating term would be SMALL.
Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds) [10 CFR 51.53(c)(3)(ii)(B)]	4.6.2	SMALL impact. There have been no indications of adverse impacts to aquatic biota within the vicinity of the discharge plume. Therefore, with continued compliance with the NPDES permit conditions, the thermal impact on aquatic organisms is SMALL.

Table 6.1-1 Environmental Impacts Related to License Renewal at CPS (Sheet 3 of 5)

Resource Issue	ER Section	Environmental Impact
Special Status Species and Habitats		
Threatened, Endangered, and Protected Species and Essential Fish Habitat [10 CFR 51.53(c)(3)(ii)(E)]	4.6.6	NO EFFECT; MAY AFFECT BUT IS NOT LIKELY TO ADVERSELY AFFECT; and NO ADVERSE EFFECTS. No refurbishment or other license-renewal related construction activities have been identified. The continued operation of the CPS site would have (1) NO EFFECT to MAY AFFECT, BUT NOT LIKELY TO ADVERSE AFFECT state and federally listed species, (2) NO EFFECT on migratory birds, and (3) NO ADVERSE EFFECTS on EFS. No mitigation measures beyond current management programs and existing regulatory controls is warranted
Historic and Cultural Resources		
Historic and Cultural Resources [10 CFR 51.53(c)(3)(ii)(K)]	4.7	No adverse impacts on historic and cultural resources. No refurbishment or other LR-related construction activities have been identified; administrative procedural controls ensure protection of these type of resources in the event of ground-disturbing activities.

Table 6.1-1 Environmental Impacts Related to License Renewal at CPS (Sheet 4 of 5)

Resource Issue	ER Section	Environmental Impact
Human Health		
Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals or Cooling Towers that Discharge to a River) [10 CFR 51.53(c)(3)(ii)(G)]	4.9.1	SMALL impact. Conditions necessary for optimal growth of pathogens is limited to water temperature in the discharge area and public access is restricted by the security control of the PA. Therefore, the public human health risk posed by CPS's thermal discharge's capacity to enhance thermophilic microorganisms is SMALL.
Electric Shock Hazards [10 CFR 51.53(c)(3)(ii)(H)]	4.9.2	SMALL impact. CPS in-scope transmission lines are in compliance with NESC clearance guidelines. Work on and near the transmission lines is governed by station procedures and CPS's comprehensive health and safety program. Given these conditions, the human health impact from electric shock hazards during the proposed LR term would be SMALL.

Table 6.1-1 Environmental Impacts Related to License Renewal at CPS (Sheet 5 of 5)

Resource Issue	ER Section	Environmental Impact
Postulated Accidents		
Severe Accidents [10 CFR 51.53(c)(3)(ii)(L)]	4.15	SMALL impact. Using appropriate qualitative screening criteria, CEG identified 11 SAMAs for CPS that have the potential to reduce plant risk and be cost-beneficial at the 95th percentile. None are related to managing the effects of plant aging during the PEO.
Environmental Justice		
Minority and Low-Income Populations [10 CFR 51.53(c)(ii)(N)]	4.10.1	No disproportionately high and adverse impacts or effects on members of the public, including minority, low-income, or subsistence populations are anticipated.
Cumulative Impacts		
Cumulative Impacts [10 CFR 51.53(c)(ii)(O)]	4.12	SMALL adverse to SMALL beneficial impacts. SMALL for land use and visual resources, air quality and noise, geology and soils, water resources, ecological resources, waste management, and human health. SMALL adverse to SMALL beneficial for climate change. SMALL beneficial for socioeconomics. No impact for historic and cultural resources.

6.2 Mitigation

6.2.1 Requirements [10 CFR 51.45(c) and 10 CFR 51.53(c)(3)(iii)]

The environmental report must include an analysis that considers and balances…alternatives available for reducing or avoiding adverse environmental effects. [10 CFR 51.45(c)]

The report must contain a consideration of alternatives for reducing adverse impacts…for all Category 2 license renewal issues….[10 CFR 51.53(c)(3)(iii)].

6.2.2 CEG Response

NRC Regulatory Guide 4.2, Supplement 1, Revision 1, specifies that the applicant should identify any ongoing mitigation and address the potential need for additional mitigation. Applicants are only required to consider mitigation alternatives in proportion to the significance of the impact. (NRC 2013b)

As discussed in Section 6.1, impacts associated with the proposed CPS LR do not require the implementation of additional mitigation measures. The permits and programs presented in Chapter 9 (i.e., NPDES permit; stormwater programs; air permit; SPCC plan; hazardous waste management program; cultural resource description process; and environmental review programs) that currently mitigate the operational environmental impacts of CPS are adequate. Therefore, additional mitigation measures are not sufficiently beneficial as to be warranted.

6.3 Unavoidable Adverse Impacts

6.3.1 Requirement [10 CFR 51.45(b)(2)]

The environmental report shall…discuss…any adverse environmental effects which cannot be avoided should the proposal be implemented….[10 CFR 51.45(b)(2)].

6.3.2 CEG Response

An environmental review conducted at the LR stage differs from the review conducted in support of a construction permit because the facility is in existence at the license renewal stage and has already operated for years. As a result, adverse impacts associated with the initial construction have been avoided, mitigated, or already occurred.

As discussed in Chapter 4, CEG does not anticipate the continued operations of CPS to adversely affect the environment. CEG also does not anticipate any LR-related refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, the environmental impacts to be evaluated for LR are those associated with continued operation during the renewal term.

CEG adopts by reference the NRC findings for the 54 Category 1 issues applicable to CPS, including discussions of any avoidable adverse impacts (NRC 2013a). In addition, CEG identified the following site-specific unavoidable adverse impacts associated with CPS:

- The majority of the land use at CPS would continue to be designated as industrial until the station is shut down and decommissioned (decommissioning can take up to 60 years after permanent shutdown of CPS).

- As discussed in Section 3.6.1.2, normal station operations result in industrial wastewater discharges containing small amounts of water treatment chemical additives to Clinton Lake at or below maximum allowable IEPA concentrations. Compliance with the NPDES permit (Attachment B) would ensure that impacts remain SMALL.

- As discussed in Section 3.6.3.1, station operations of CPS results in consumptive water use of Clinton Lake, and CPS uses a once-through cooling system that withdraws and discharges cooling water to the lake with minimal net loss.

- Operation of CPS results in the generation of SNF and waste material, including LLRW, hazardous waste, and nonhazardous waste. Specific station design features in conjunction with a waste minimization program, employee safety training programs and work procedures, and strict adherence to applicable regulations for storage, treatment, transportation, and ultimate disposal of this waste ensure that the impact is SMALL.

- Operation of CPS results in a very small increase in radioactivity in the air and water emissions. The incremental radiation dose to the local population resulting from CPS operations is typically less than the magnitude of the fluctuations that occur in natural background radiation. Doses to the public from CPS's gaseous releases would be well within the allowable limits of 10 CFR Part 20 and 10 CFR Part 50, Appendix I. Operation of CPS also creates a very low probability of accidental radiation exposure to inhabitants of the area.

6.4 Irreversible or Irretrievable Resource Commitments

6.4.1 Requirement [10 CFR 51.45(b)(5)]

The environmental report shall…discuss…any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented [10 CFR 51.45(b)(5)].

6.4.2 CEG Response

The term "irreversible" applies to the commitment of environmental resources (e.g., permanent use of land) that cannot by practical means be reversed to restore the environmental resources to their former state. In contrast, the term "irretrievable" applies to the commitment of material resources (e.g., irradiated steel, petroleum) that, once used, cannot by practical means be recycled or restored for other uses. The continued operation of CPS for the proposed LR operating term would result in irreversible and irretrievable resource commitments, including the following:

- Uranium in the nuclear fuel consumed in the reactor that becomes high-level radioactive waste if the used fuel is not recycled through reprocessing.
- Land required for permanent storage or disposal of SNF, LLRW generated as a result of station operations, and sanitary waste generated from normal industrial operations.
- Elemental materials that would become radioactive.
- Materials used for the normal industrial operations of CPS that cannot be recovered or recycled, or that are consumed or reduced to unrecoverable forms.

No LR-related refurbishment activities have been identified that would irreversibly or irretrievably commit significant environmental components of land, water, and air.

If CPS ceases operations on or before the expiration of the current OL, the likely power generation alternatives would require a commitment of resources for construction of the replacement station as well as for fuel to run the station. Significant resource commitments would also be required if transmission lines are needed to connect a replacement generation plant to the electrical grid.

6.5 Short-Term Use Versus Long-Term Productivity of the Environment

6.5.1 Requirement [10 CFR 51.45(b)(4)]

The environmental report shall…discuss…the relationship between local short-term uses of man’s environment and the maintenance and enhancement of long-term productivity….[10 CFR 51.45(b)(4)].

6.5.2 CEG Response

The current balance between short-term use and long-term productivity of the environment at the site has remained relatively constant since CPS began operations. The Final Environmental Statement for CPS evaluated the relationship between the short-term uses of the environment and the maintenance and enhancement of the long-term productivity associated with the construction and operation of CPS (NRC 1982). The proposed LR operating term would not alter the short-term uses of the environment from the uses previously evaluated in the CPS Final Environmental Statement. The proposed LR operating term would postpone the availability of the site resources (land, air, water) for other uses. Denial of the application to renew the CPS OL would lead to the shutdown of the station and would alter the balance in a manner that depends on the subsequent uses of the site. For example, the environmental consequences of turning the site area occupied by CPS into a park or an industrial facility after decommissioning are quite different. Extending CPS operations would not alter, but only postpone, the potential long-term uses of the site that are currently possible.

In summary, no LR-related refurbishment activities have been identified that would alter the evaluation of the CPS FES for the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity of these resources.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

The environmental report shall . . . discuss . . . alternatives to the proposed action . . . . [10 CFR 51.45(b)(3)]

The applicant shall discuss in this report the environmental impacts of alternatives and any other matters . . . . The report is not required to include discussion of need for power or economic costs and benefits of . . . alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation . . . . [10 CFR 51.53(c)(2)]

A reasonable alternative must be commercially viable on a utility scale and operational prior to the expiration of the reactor's operating license, or expected to become commercially viable on a utility scale and operational prior to the expiration of the reactor's operating license . . . . The amount of replacement power generated must equal the base-load capacity previously supplied by the nuclear plant and reliably operate at or near the nuclear plant's demonstrated capacity factor (NRC 2013a, GEIS Section 2.3)

7.1 No-Action Alternative

As described in Section 2.1, the proposed action is to renew the CPS OL for an additional 20-year period. The only other alternative under consideration is the no-action alternative, which would be the decision *not* to renew the CPS OL. If the CPS OL is not renewed, the 1,080 MWe (net generation) of baseload power would not be available for distribution. CPS’s electricity production is supplied to the central region of the Midcontinent Independent System Operator (MISO) transmission network (OMS 2021). The no-action alternative will identify replacement power sources for the loss of CPS generation.

In accordance with 10 CFR 51.53(c)(2), this ER will discuss a no-action alternative to the proposed OL renewal and a range of alternatives for replacement baseload power sources. A reasonable alternative as described by the NRC must be commercially viable on a utility scale and operational prior to the expiration of the reactor’s OL or expected to become commercially viable on a utility scale and operational prior to the expiration of the reactor’s OL (NRC 2013a). The replacement power alternative generation must also provide adequate baseload power capacity that was previously supplied by the nuclear plant.

The replacement power sources being considered under the no-action alternative are presented in Section 7.2.1. Section 7.2.2 describes the no-action alternative power sources evaluated that were not considered reasonable power sources for the replacement of the CPS generation.

7.1.1 Decommissioning Impacts

The NRC’s definition of decommissioning, as stated in 10 CFR 20.1003, is the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits the following:

- Release of the property for unrestricted use and termination of the license; or
- Release of the property under restricted conditions and termination of the license.

The NRC-evaluated decommissioning options include the following:

- Immediate dismantling soon after the facility closes.
- Safe storage and monitoring of the facility for a period of time that allows the radioactivity to decay, followed by dismantling and additional decontamination.
- Permanent entombment on the site in structurally sound material such as concrete that is maintained and monitored.

All the decommissioning options must be completed within a 60-year period following permanent cessation of operations and permanent removal of fuel.

Under the no-action alternative, CEG would continue operating CPS until the existing OL expires. Upon expiration of the OL, CEG would initiate decommissioning procedures in accordance with NRC requirements. The NRC GEIS evaluated decommissioning environmental impacts for land use, visual resources, air quality, noise, geology and soils, hydrology, ecology, historic and cultural resources, socioeconomics, human health, environmental justice, and waste management and pollution prevention. CEG considers the GEIS description of decommissioning impacts as representing the actions it would perform for the CPS decommissioning (NRC 2013a). Therefore, CEG relies on the NRC's conclusions regarding the environmental impacts of decommissioning CPS.

Decommissioning and its associated impacts are not considered evaluation criteria used to proceed with the proposed action or select the no-action alternative. CPS will be decommissioned eventually, regardless of the NRC decision on license renewal and license renewal would only postpone decommissioning for another 20 years. The GEIS states the timing of the decommissioning does not change the environmental impacts associated with this activity. The NRC’s findings, as described in 10 CFR 51, Subpart A, Appendix B, Table B-1, state that delaying decommissioning until after the renewal term would result in SMALL environmental impacts. CEG relies on the NRC's findings.

The primary criteria used to evaluate the proposed action and the no-action alternative are the power options available for replacement of CPS generation. CEG concludes that the decommissioning impacts under the no-action alternative would not be substantially different from those following license renewal as identified in the GEIS. Decommissioning impacts would be SMALL and could overlap with operation of a CPS replacement.

7.2 Energy Alternatives that Meet System Generating Needs

In accordance with 10 CFR 51.53(c)(2), CEG considered a range of alternatives to replace generation if the CPS OL is not renewed. CEG considered each of the replacement alternatives identified in the GEIS for license renewal (NRC 2013a). These alternatives were evaluated based on their ability to provide reliable baseload power and to be operational prior to the expiration of the current OL.

7.2.1 Energy Alternatives Considered as Reasonable

A reasonable alternative as described by the NRC must be commercially viable on a utility scale and operational prior to the expiration of the reactor's OL or expected to become commercially viable on a utility scale and operational prior to the expiration of the reactor's OL. The replacement power alternative generation must also provide approximately 1,080 MWe net baseload power previously supplied by the nuclear plant. Reasonable alternatives must also comply with the Climate and Equitable Jobs Act (CEJA), which was signed into law in 2021. The CEJA calls for the shutdown of fossil fuel fired generation in Illinois between 2030 and 2045; however, it allows a natural gas plant to continue operation after 2045 based on grid reliability requirements (Illinois Public Act 102-0662, Section 9.15). The intent of the CEJA is to transition Illinois to 100 percent clean energy by 2050 (ICC 2022). The alternatives analysis identified the following power sources as meeting the NRC criteria for reasonableness in the replacement of CPS generation during the proposed LR operating term. These energy alternatives considered reasonable are further discussed in Section 7.2.3.

- Natural Gas Alternative –
  - NGCC combustion plant with MDCTs located onsite.
- Renewable and natural gas combination alternative –
  - NGCC combustion plant with MDCTs located onsite.
  - Solar panels with lithium-ion battery storage located onsite.
  - Wind turbines located onsite.
- Purchased Power

7.2.2 Energy Alternatives Not Considered Reasonable

The full range of energy alternatives as described in the GEIS include power sources that will require development of new generation and power alternatives that will not require new generation, such as purchased power (NRC 2013a). CEG considered all the alternatives described in the GEIS for replacement of the CPS generation. This section will address the energy alternatives that were not considered reasonable for additional evaluation.

7.2.2.1 CEG Plant Reactivation or Extended Service Life

CEG has generating assets that support various regional electric grid networks. CEG has several fossil fuel-fired generating plants (natural gas-fired, oil-fired, and dual natural gas and oil-fired) (CEG 2022b). CEG does not have any coal-fired plants, operating or in shutdown, in its fleet (EGC 2017). CEG does not have any natural gas or oil-fired plants in Illinois or the MISO central region. CEG nuclear generation assets located in Illinois other than CPS include the following units: Braidwood, Byron, Dresden, LaSalle, and Quad Cities. (CEG 2022c) All these plants are currently operating under OLs which extend beyond CPS's OL expiration and would not be available as a plant for reactivation or extended service life in order to replace CPS generation (NRC 2021). Therefore, plant reactivation and extended service life is not considered a reasonable alternative.

7.2.2.2 Conservation and Energy Efficiency Measures (Demand-Side Management)

Demand-side management (DSM) includes demand response that shifts electricity from a peak-use period to times of lower demand, and energy efficiency or conservation programs that reduce the amount of electricity required for existing activities and processes. A DSM alternative would be required to reduce the baseload demand by 1,080 MWe to be considered a reasonable alternative. Reliance on DSM as a reasonable alternative to CPS is uncertain because it relies on voluntary participation rather than mandatory energy efficiency from compliance with codes and standards (e.g., building codes and appliance energy use ratings) and realized savings of energy needed to replace CPS's large capacity. CEG is a merchant generator in Illinois and does not have a service territory with a customer base for which it is responsible for meeting their power needs, therefore there are no state policy or law requirements for commercial merchant utility company to implement DSM programs. As such, DSM is not a reasonable replacement alternative for CPS.

7.2.2.3 New Nuclear

In 1987, the Illinois State Legislature passed legislation prohibiting the construction of any new nuclear power plant within Illinois after September 11, 1987 (220 ILCS 5/8-406). According to this legislation, no new certificates/authorizations would be issued until the US government has identified and approved a demonstrable technology or means for the disposal of high-level nuclear waste, or until such construction has been specifically approved by a statue enacted by the Illinois General Assembly. In 2023, the Illinois State House and Senate passed legislation (Senate Bill 76) to lift the long-standing moratorium on the construction of new nuclear energy generation sources in Illinois. However, Senate Bill 76 was vetoed by the Governor of Illinois in August 2023. (IGA 2023)

Further, should the moratorium be rescinded in the future, the time needed for licensing, constructing, and startup testing for a replacement nuclear power station (whether conventional light-water reactor or small modular reactor) prior to CPS's license expiration date provides too much uncertainty for it to be a reasonable discrete alternative.

7.2.2.4 Wind

The renewable and natural gas combination alternative includes a wind component. However, fully replacing CPS's generating capacity with a discrete wind alternative would require more than one utility scale wind farm, effectively multiplying the potential environmental impacts, particularly the land use and terrestrial ecology impacts.

The land needs for wind generation include land parcel(s) that can host a wind farm where turbines are spaced for operation and linked with other turbines and with power converters and connections with transmission infrastructure. Within the wind farm acreage, land would be permanently disturbed for wind turbine bases and power infrastructure as well as temporarily disturbed for construction areas such as laydown and worker support areas. The DOE developed three land use metrics for these acreage considerations — 0.74 acres per megawatt (MW) for permanent structures, 2.47 acres (inclusive of the 0.74 acres for permanent structures) per MW for construction footprint, and 85 acres per MW for wind farm boundaries (DOE 2015). To replace 1,080 MWe from CPS with wind power would require about 2,610 MWe based on the average wind generation capacity of 41.4 percent (DOE 2021a). Based on the DOE metrics, the acreage requirements are about 222,000 acres for wind farms, 6,500 acres for construction footprint, and 2,000 acres for permanent structures. To achieve the required MW capacity, the wind farm acreage would require many installations to bring together enough available land parcels, each with the potential to significantly impact land use even with the spaced wind turbines allowing for compatible uses such as crop cultivation.

Wind typically cycles significantly over a 24-hour period, is not dispatchable, and low-capacity factors can be experienced for several days at a time due to variable wind patterns. Therefore, wind generation by itself is not capable of providing baseload power. For a wind farm to replace a baseload energy source, capacity significantly in excess of CPS generation coupled with large amounts of energy storage would have to be included for the facility. Installation of batteries to provide firm power, compensating for wind's intermittent nature, could further increase acreage requirements.

Illinois has potential for wind generation in the area surrounding CPS, where wind resources range from 7.0 to 7.9 meters/second at 100 meters above surface level. Elsewhere in Illinois wind resources exist ranging between 6.0 to 7.9 meters/second at 100 meters above surface level. (NREL 2021a) Siting would require careful consideration to terrestrial ecology, wildlife habitat, and other environmental concerns. Currently, wind energy accounts for 10.66 percent of power generation within Illinois, with a cumulative installed capacity of approximately 7,000 MW (DOE 2021b).

Other impacts from wind generation include impacts to terrestrial ecology from land disturbance and avian mortality from operations. Depending on the location of the wind facilities, the land use disturbances could result in moderate to large impacts on wildlife habitats, vegetation, land use, and aesthetics. Therefore, discrete wind would not be a superior alternative to continued operation of CPS.

As presented above in Section 7.2.2.1.2, CPS supplies power to the MISO central region electrical grid. Illinois as well as Indiana, Michigan, and Wisconsin are within the MISO central region and borders one or more of the Great Lakes. Thus, there is the potential for offshore wind generation within the MISO central region. Siting would require careful consideration to bathymetry, shipping lanes, fishing rights, wildlife migration patterns, and other environmental concerns. Wind installations also pose aesthetic impact concerns, and the larger turbines require greater offshore distances to minimize aesthetic impacts. There are currently no offshore wind installations on the Great Lakes. The first is anticipated to be the Icebreaker Wind demonstration project of 20.7 MW in Lake Erie offshore from Cleveland, Ohio, currently approved by the Ohio Power Siting Board (CC 2021). Due to the potential legislative, environmental, and aesthetic impacts discrete offshore wind power is not a reasonable replacement alternative for CPS.

7.2.2.5 Solar

The renewable and natural gas combination alternative includes a solar component. However, fully replacing CPS's generating capacity with a discrete solar alternative would require several utility-scale solar installations, effectively multiplying the potential environmental impacts, particularly the land use and terrestrial ecology impacts. Solar generation is intermittent by nature, typically cycles significantly over a 24-hour period, is not dispatchable, and low-capacity factors can be experienced for several days at a time due to cloud cover. This type of generation volatility on a large scale can create distribution and/or transmission instability. For solar power to be viable as a discrete source of large amounts of energy that is reliably available for the regional grid at all hours of the day, capacity significantly in excess of the CPS generation coupled with large amounts of battery storage would be needed to produce energy for storage.

Due to the amount of solar generating capacity needed to replace the entire CPS baseload generation and the lower efficiencies in producing electricity from solar power versus nuclear power, the land acreage required for a discrete solar alternative is larger than, or similarly large as, other alternatives being considered in this ER. Using a capacity factor of 25 percent (EIA 2022a), replacing the 1,080 MW CPS would require about 4,320 MW. The Illinois Solar Energy Association estimates the development of 2,000 MW of additional solar energy generation by 2025, requiring 10,000-15,000 acres of land at approximately 5-7.5 acres per MW (ISEA 2021). Using this assumption of 5-7.5 acres per MW, between 21,600-32,400 acres would be required to replace CPS with solar. Furthermore, installation of batteries to provide firm power, compensating for the intermittent nature of solar, could further increase acreage requirements. To acquire this much acreage through purchase or lease would require many installations, each with the potential to significantly impact land use. Depending on the location of the solar facilities, the land use disturbances could result in moderate to large impacts on wildlife habitats, vegetation, land use, and aesthetics. Therefore, discrete solar would not be a superior alternative to continued operation of CPS.

A solar alternative using distributed solar involving solar panels installed on residential and commercial buildings would avoid the land use impacts. Such a distributed system would rely on the participation of the property owners and would have the same uncertainties as discussed in Section 7.2.2.3 for DSM. Reliance on distributed rooftop solar as a reasonable alternative to CPS is uncertain because it relies on voluntary participation and requires compliance with codes and standards (e.g., building codes and property covenants) and realized reduced consumption at those properties as well as extra energy being fed back to the regional grid. The National Renewable Energy Laboratory (NREL) (NREL 2020a; NREL 2020b) developed estimates for the potential generating capacity of solar photovoltaic (PV) panels that could be installed on residential and commercial properties in each state. NREL's estimate for Illinois is 38,169,340 megawatt hours (MWh) (NREL 2020a). To fully replace CPS generation with distributed solar on rooftops require approximately 70 percent of the available rooftop space for the entire state of Illinois. Moreover, the NREL cautions that its estimation could be overestimating the available rooftop space -- "The technical generation potential of residential and commercial rooftop PV provides an upper bound of feasible development potential for planning purposes. Technical generation potential does not consider economic or market feasibility. The technical generation potential of residential and commercial rooftop PV is estimated by combining modeled suitable rooftop area with solar resource availability and quality and system performance data . . . Technical potential does not account for existing systems." (NREL 2021b) Given the uncertainties in and impractical rooftop requirements for implementation of distributed solar on the required scale, distributed solar is not a reasonable replacement alternative for CPS.

7.2.2.6 Combination of Wind and Solar

As stated above in Sections 7.2.2.4 and 7.2.2.5, the renewable and natural gas combination alternative includes wind and solar components along with a natural gas-fired plant. This section presents an alternative of multiple wind facilities and multiple solar facilities to cumulatively provide full replacement for the CPS generation. In addition, to provide full replacement, the facilities would require battery storage. CEG considered a range of scenarios to understand the land use impact of such a renewable combination alternative including combinations of 70 percent of replacement being provided by wind and 30 percent by solar, 50 percent from each, and 30 percent from wind and 70 percent from solar. For simplicity, it is assumed that battery storage at each site could be accommodated within the acreage footprint of the wind or solar facility. The capacity factors of 41.4 percent and 25.0 percent for wind and solar facilities respectively, were used. Additional land would be needed for transmission connections to the new wind and solar facilities. CEG assumes 25 miles of new 345-kV transmission lines in a new 150-foot-wide ROW transmission corridor would need to be developed to support each solar and wind installation, which results in an acreage requirement of 455 acres for each facility. The table below presents the disturbed acreage for the three scenarios. The disturbed acreage accounts for the permanent and construction support facilities for wind using the land use factor of 2.47 acres per MW presented in Section 7.2.2.4, 7.5 acres per solar MW presented in Section 7.2.2.5 as the upper range of land per MW, and the 455 acres for transmission connection.

Scenario	MW wind/number of 300 MW facilities	MW solar/number of 125 MW facilities	Disturbed Acreage (facilities and transmission)
70% wind 30% solar	1,826/7	1,296/11	22,400
50% wind 50% solar	1,304/5	2,160/18	29,900
30% wind 70% solar	782/3	3,024/25	37,300

Just as for the discrete wind and solar alternatives, depending on the location of the facilities and transmission corridors, the land use disturbances could result in moderate to large impacts on wildlife habitats, vegetation, land use, and aesthetics. Therefore, a combination of wind and solar would not be a superior alternative to continued operation of CPS. In addition, the time required for the site selection, land acquisition, certification by the Illinois Power Agency, permitting, and construction of each facility would likely exceed the OL expiration date. Considering the estimated 18 separate sites for the scenario of 70 percent wind and 30 percent solar, and the 28 separate sites for a 30 percent wind and 70 percent solar scenario, these feasibility challenges make this alternative impractical.

7.2.2.7 Hydropower

Construction of a new dam and hydropower facility would require significant siting considerations, such as the area that would be inundated to provide water storage for generation, as well as the overall environmental impacts associated with the development of the facility. The environmental impacts could be moderate or large for land use, water resources, socioeconomics, ecology, and cultural resources for a single location and replacement of the CPS generation would require the development of multiple locations.

The DOE's Oak Ridge National Laboratory assessed the ability of existing non-powered dams across the country to generate electricity. The study assessed the dam with the greatest generation potential in Illinois to be approximately 496 MWe, the Ohio River Locks & Dam at the Illinois/Kentucky border. (ORNL 2012) The US Energy Information Administration reports the capacity factor for hydropower to be approximately 40 percent (EIA 2022a). The non-powered dams in Illinois within the MISO central region collectively do not provide the scale of power generation capacity needed to replace CPS's generation capacity.

The lack of hydropower potential at existing dams in Illinois and the environmental constraints associated with the development of a new hydropower facility make hydropower an unreasonable alternative to replace the CPS generation.

7.2.2.8 Geothermal

The NREL graded the geothermal resources of the United States. Much of Illinois is graded as having the second to least potential for geothermal energy with a small portion having a moderate potential. (NREL 2018) Therefore, geothermal energy is not considered a reasonable power source for the replacement for CPS.

7.2.2.9 Biomass

Biomass includes wood waste, municipal waste, manure, certain crops, and other types of waste residues used to create electricity. Using biomass-fired generation for baseload power depends on the geographic distribution, available quantities, constancy of supply, and energy content of biomass resources. Biomass, which is primarily from waste and landfill gas, accounts for the second smallest share of renewable electricity generation in Illinois, surpassing only hydroelectric. There are 13 utility-scale power plants fueled with biomass in Illinois, which combined produce approximately 73 MW of energy. (EIA 2022c)

Biomass plants tend to be much smaller than nuclear or fossil fuel plants. To replace the CPS baseload generation, it would take the construction of many biomass plants located near reliable fuel sources that continuously produce enough biomass to fuel the plants. Average size biomass plants are generally 50 MWe, with the largest ones being 120-140 MWe (BM 2022). Replacing the generating capacity of CPS using only biomass would require the construction of eight or nine large facilities.

Biomass plants require storage facilities for the fuel products and for waste ash/residue for the wood, crop, and agriculture waste types. Wood waste plants require a large land area for storage and processing, and, like coal generation, they produce ash that must be disposed of in a manner that does not pollute waterways and air. Therefore, environmental impacts associated with construction of a wood waste plant could be moderate to large, with the impact intensity level being dependent on the siting and proximity to a source of wood waste.

Utilizing municipal solid waste for electricity is also dependent on being close to large population centers that generate large amounts of waste. Air emissions are also an issue with biomass plants, and construction of a plant would require installation of maximum achievable control technology to comply with the CAA.

Overall, the construction and operation of biomass plants of the size necessary to act as an alternative to CPS would result in moderate to large environmental impacts to land use, water quality, ecological resources, and air quality and would not be a superior alternative to continued operation of CPS.

7.2.2.10 Fuel Cells

Current fuel cell installations for large-scale stationary power are significantly smaller scale than what is needed as a reasonable replacement of CPS's generating capacity with many of the systems installed for individual customers. Larger applications generally provide from hundreds of kWs to tens of MWs of power (DOE 2020). As of January 2020, the United States had 550 MW of stationary fuel cell generation capacity (FCHEA 2020). Fuel cells as a utility-scale generation alternative are not presently competitive with other alternatives. Additionally, developments in fuel cell technology are too uncertain at this time to consider this a viable alternative. Therefore, fuel cells are not considered a reasonable alternative to CPS's baseload generation.

7.2.2.11 Ocean Wave and Current Energy

The Federal Energy Regulatory Commission has licensing authority over hydrokinetic energy projects deployed in the United States. Currently, there is only one licensed inland project, a project of 70 kilowatts (kW) (FERC 2022).

Given hydrokinetic technology is in the early stages of commercial application and projects have low generation capacities, ocean wave and current energy is not considered a reasonable alternative to CPS's baseload generation.

7.2.2.12 Petroleum-fired

Oil-fired generation emits large amounts of carbon dioxide and HAPs, making it undesirable for utilities looking to reduce air pollutants and comply with regulations. CEJA requires that all greenhouse gas-emitting units that use oil as a fuel are required to permanently reduce CO_2 emissions to zero no later than 2030 (Illinois Public Act 102-0662 Section 9.15(g)). Based on the greater environmental impacts and cleaner energy source policies and regulations, oil-fired generation is not a reasonable alternative.

7.2.2.13 Coal-fired

Coal-fired plants are being retired throughout the United States to reduce carbon emissions and address concerns with ash storage and disposal. Illinois' CEJA requires that all greenhouse gas-emitting units that use coal as a fuel are required to permanently reduce CO_2 emissions by 2030 (Illinois Public Act 102-0662 Section 9.15(g)). Based on the greater potential environmental impacts and the CEJA restrictions, coal-fired generation is not a reasonable alternative.

7.2.3 Environmental Impacts of Alternatives

7.2.3.1 Natural Gas-Fired Generation

A NGCC plant would consist of multiple combustion turbines, a heat recovery steam generator, and a steam turbine generator. Based on a capacity factor of 87 percent, the NGCC plant would have a design capacity of 1,241 MWe (gross) of generation to replace the current 1,080 MWe provided by CPS (EIA 2022d).

7.2.3.1.1 Land Use

Approximately 54 acres would be needed for siting a replacement NGCC based on a National Energy Technology Laboratory (NETL) factor of m^2/MWh (NETL 2010). As presented in an Early Site Permit (ESP) application for siting a new nuclear unit at the CPS site, the CPS site has available land for siting additional generation facilities (EGC 2006). The CPS site has available land for siting a replacement NGCC plant. The application proposed siting a new nuclear unit adjacent to the existing unit within the fenced industrial area, utilizing approximately 96 acres (EGC 2006). This same 96-acre area could be used for the NGCC plant. The existing transmission infrastructure and corridors are assumed to be adequate to support a replacement NGCC plant. No natural gas transmissions lines currently exist near the CPS property, so extension of pipelines to supply the NGCC replacement plant would be necessary. The closest natural gas distribution pipeline is a section of the Gulf Coast Natural Gas Pipeline that runs north-south through McClean County and Piatt County east of Farmer City (USDOT 2022b). A pipeline extension to the CPS site would be approximately 16 miles long.

Given the existing natural gas supply in the United States, it is assumed that natural gas supply is adequate without the need for additional well development.

As presented in Section 3.2.1, the power generating portion of the CPS site is zoned as General Industrial District (I). Siting the replacement NGCC plant there would not result in land use conversion. Installation of the natural gas pipeline would require some land conversion, but existing utility ROWs could be used where practical. Therefore, the overall impact on land use for the NGCC plant would be SMALL.

7.2.3.1.2 Visual Resources

Use of an existing power plant site would allow the additional structures to blend in with the existing ones during construction as well as operation. The tallest structures would be the exhaust stacks and some portion of these structures would likely be visible for one mile or more. The exhaust stack(s) would be lighted as required by Federal Aviation Administration (FAA) requirements. In general, there would also be more lighting visible across the night landscape from the addition of the NGCC plant. At the CPS site, the viewscape would still be dominated by the reactor containment dome and turbine building. The area surrounding the CPS site is a mixture of moderately and sparsely vegetated, and the addition of a NGCC plant would likely be visible from nearby waterways and recreation areas due to minimal tree coverage. The additions to the viewscape would be similar in type and magnitude to the existing station and the impact to visual resources would be SMALL to MODERATE.

7.2.3.1.3 Air Quality

Temporary and minor effects on local ambient air quality could occur as a result of construction activities. Fugitive dust and fine PM would be generated during earthmoving activities, material-handling activities, by wind erosion, and other activities, and managed in accordance with regulatory requirements and BMPs (e.g., paving or stabilizing disturbed areas, water suppression, reduced material handling) would minimize such emissions. Vehicles used to haul debris, equipment, and supplies, as well as equipment used for earthmoving, would create pollutants. All equipment would be serviced regularly, and all industrial activities would be conducted in accordance with federal, state, and local emission requirements. Emissions from construction activities would be temporary and intermittent for the duration of construction activities. With implementation of mitigation measures and properly serviced equipment impacts would be SMALL.

The operational NGCC plant would be equipped with air pollution controls to ensure compliance with air quality regulations. Emission estimates for the NGCC plant based on EPA AP-42 10 emission factors are shown in Table 7.2-1.

The NGCC plant would qualify as a new major source of criteria pollutants and would be subject to the CAA prevention of significant deterioration air quality review or the CAA nonattainment new source review. Therefore, the plant would have to comply with the NSPS for NGCC plants set forth in 40 CFR Part 60 Subpart KKKK and 40 CFR Part 60 Subpart TTTT. The plant would also qualify as a major source because of its potential to emit more than 100 tons per year of criteria pollutants. The plant would be required to obtain a Title V operating permit.

The NGCC plant would be subject to the national emission standards for HAPs for stationary combustion turbines if the plant were a major source of HAPs, having the potential to emit 10 tons per year or more of any single HAP or 25 tons per year or more of any combination of HAPs [40 CFR 63.6085(b)]. A new NGCC plant would also have to comply with Title IV of CAA [42 USC 7651] reduction requirements for SO_2 and nitrogen oxide, which are the main precursors of acid rain and the major causes of reduced visibility.

Cooling towers would have air emissions and atmospheric effects from drift and plumes. Cooling tower drift consists of the liquid droplets entrained in the exhaust air stream. A plume forms when the saturated water vapor that leaves the top of the tower encounters cooler air and very small water droplets condense out of the air. Drift that leaves the top of the tower would reflect the same water chemistry as that of the circulating water. The water chemistry would be controlled and would be in accordance with any applicable limits and restrictions for use of water treatment chemicals and discharge limits.

When the small droplets within the drift or plumes are released into the air, evaporation occurs, leaving behind the solids that were once dissolved. This has the effect of introducing fine PM into the atmosphere. PM emissions (e.g., PM_{10} and $PM_{2.5}$) are regulated air emissions. The dissolved solids from both drift and plumes could also be deposited on the surrounding land. However, impacts on vegetation due to the deposition would be expected to be localized and primarily on site. Atmospheric effects of plumes from the MDCTs could include icing, fogging, and shadowing.

The impacts to local air quality during construction would be similar to any large-scale building project and would be conducted in compliance with applicable regulations and permits. Air quality impacts of construction would be SMALL. A new NGCC plant would be a major source of criteria pollutants and GHGs. Compliance with existing air quality regulations would ensure air quality impacts are minimized. Therefore, the operations-related impacts on air quality under the NGCC plant alternative would be MODERATE.

7.2.3.1.4 Noise

Sources of noise during construction would include clearing, earthmoving, foundation preparation, pile driving (if needed), concrete mixing and pouring, steel erection, and various stages of facility equipment fabrication, assembly, and installation. Additionally, a substantial number of diesel- and gasoline-powered vehicles and other equipment would be used. The size of the CPS site would allow considerable sound level attenuation to offsite receptors. Illinois has a noise regulation with allowable octave-band sound levels according to emitting and receiving land-use classification and time of day (IPCB 2015). DeWitt County does not have a noise ordinance. The sound level from most construction activities would be expected to be below the 60 to 65 dBA range of acceptable day-night average noise levels set by HUD at the site border. Construction activities resulting in offsite sound levels above this range would be temporary.

Extension of natural gas transmission pipelines to supply the NGCC replacement plan would include similar sources of noise, as mentioned above, with construction occurring both on and offsite. BMPs would be implemented, and local and state noise regulations would be followed to reduce temporary noise disturbance. Noise impacts associated with plant operations would include noise from transformers, turbines, pumps, compressors, exhaust stack, combustion inlet filter house, condenser fans, the cooling towers, high-pressure steam piping, and loudspeakers. As stated above, the NGCC would be constructed at an existing power plant site, which is a setting where the noisy activity of an operational industrial site is acceptable. Further, the plant would operate in compliance with any applicable state and local noise ordinances. Construction and operations-related noise impacts would be SMALL.

7.2.3.1.5 Geology and Soils

Construction-related impacts to geology would be minimal as excavation would be shallow enough to not be expected to damage geologic formations. In addition, materials such as stone and gravel used in the construction would be sourced from local quarries and other local or regional sources. Therefore, construction-related impacts to geology would be SMALL.

For construction of CPS, the area surrounding the land that the operating unit occupied was also disturbed. The area considered in the ESP for a new unit is within this previously disturbed area that remains largely cleared. Construction-related impacts to soil would occur during filling, construction of the plant in the ESP new unit site and associated pipeline extensions. The exposure of soils during clearing and grubbing would increase the risk of erosion from precipitation and high wind events. Soils excavated and removed during clearing and construction would be stockpiled on site for use as backfill after construction is completed. Because the ground disturbance would exceed one acre, CEG would obtain a NPDES construction stormwater general permit from IEPA (IEPA 2023). This is a general permit for construction activities that have the potential to discharge stormwater to surface water bodies or storm sewers. Overall, with the installation and implementation of BMPs, construction-related impacts to soils would be SMALL.

Operations-related impacts on geology and soils from the NGCC plant would be minimized by adherence to the industrial stormwater permit governing the power plant site. The IEPA general stormwater permit requires a SWPPP, a SHPO approval letter and an EcoCAT letter of approval (IEPA 2023). Operations-related impacts would be SMALL.

7.2.3.1.6 Hydrology (Surface Water and Groundwater)

The construction-related impacts to surface water include those related to construction of the NGCC plant and extension of natural gas transmission lines that would alter surface drainage features. The clearing of vegetation on the construction site may alter drainage features that convey runoff. The CPS site is a combination of field and sparse tree coverage where enough acreage, approximately 54 acres, is available for the NGCC plant. The impacts from drainage alterations would be minimized by the implementation of BMPs identified in the stormwater general permit and erosion control and stormwater management plan. Adherence to stormwater controls would minimize sediment release and provide protection to nearby waterbodies from accidental releases of oils or other chemicals being used.

Existing intake and discharge structures would be used if practical. If not, new, or modified structures would be constructed in or along the shoreline under a CWA Section 404 permit from the USACE, IEPA and other applicable state agencies.

Through compliance with permit conditions and implementation of BMPs, surface water impacts from NGCC plant construction would be SMALL.

Water needs for NGCC plant construction would be similar to typical uses of water for large industrial projects. These uses include dust abatement, concrete mixing, and potable water. In addition, construction could require minimal dewatering of excavations. CEG assumes water used for construction would be obtained from Clinton Lake and not from groundwater. Surface water and groundwater use impacts from construction would be SMALL.

Operations-related water use would be primarily for cooling water makeup and would be sourced from nearby surface water sources. Closed cycle cooling would result in water consumption due to evaporation and drift. The NGCC plant would have surface water withdrawals of approximately 1,900 million gallons of water per year (MGY) and consume approximately 1,400 MGY based on the water use factors developed by the NETL of 175 gal/MWh for withdrawals and 133 gal/MWh for consumption (NETL 2011). NETL estimated that nuclear plants with recirculating cooling would consume substantially more water at 578 gal/MWh (NETL 2011). Water consumption for once-through cooling is substantially less at 127 gal/MWh or 0.4 percent of withdrawals (NETL 2011). As presented in Table 3.6-4a, CPS's average water withdrawal from 2018–2022 was approximately 275,000 MGY. Based on NETL withdrawal and consumption rates for once-through cooling at nuclear plants, CPS's average annual consumption is an estimated 1,000 MGY. Therefore, the water consumption of the

NGCC plant would be greater than CPS, but well under a nuclear plant using recirculating cooling.

The NRC assessed the water use impact from the addition of a nuclear unit at CPS when CEG, formerly EGC applied for an ESP. The NRC determined the impact of increasing water use of Clinton Lake from an additional nuclear unit would be small except in years of below-average precipitation, when it could be moderate (NRC 2006, Section 5.3.2).

Surface water use and quality impacts from operating the natural gas alternative would be SMALL. A new NPDES permit or modifications to the existing permit would be required for the NGCC plant discharge. Adherence to the NPDES permit would minimize impacts to water quality.

NGCC plant operations would require potable water for drinking and sanitary purposes. CPS withdraws water from Clinton Lake and treats it onsite to provide potable water for the station (Section 3.6.3.1). The NGCC plant would also use Clinton Lake as a source for potable water rather than groundwater. Groundwater quality impacts would be mitigated through use of BMPs and stormwater systems on the industrial site. In addition, waste management and spill mitigation would minimize the spread of contaminants through the soil into the groundwater. Therefore, operations-related impacts on groundwater use and quality would be SMALL.

7.2.3.1.7 Ecological Resources (Terrestrial and Aquatic)

Terrestrial

Terrestrial ecology impacts resulting from the construction of the NGCC plant and extension of natural gas transmission lines would primarily result from land clearing, noise, and emissions of construction activities. As discussed above in Section 7.2.3.1.1, the replacement NGCC plant could be sited within the fenced area of the industrial site, an area that was largely disturbed for construction of CPS and due to its proximity to the operating station, does not provide high-quality habitat. The clearing of vegetation and tree removal could displace wildlife that occupies the industrial site, and these would disperse to nearby habitats.

Based on implementation of construction BMPs for erosion and dust control, noise abatement, proper equipment maintenance, adherence to tree removal requirements for protected species, and adherence to applicable permit conditions, the overall impact of construction-related activities on terrestrial ecological resources would be SMALL.

Operational impacts on terrestrial resources would be similar to those occurring with the operation of CPS. With the impacts to terrestrial ecology being nearly all attributable to land clearing and habitat removal during construction, the impacts attributable to operations would be SMALL.

Aquatic

Impacts on aquatic resources during construction would be minimal through implementation of BMPs, which would minimize impacts from surface water discharges and shoreline construction needed to construct a new or modify the existing intake and discharge structures. Construction for the intake and discharge structure could require dredging which would require a CWA Section 404 permit from the USACE, IEPA and other applicable state agencies. Permit conditions would address measures to reduce impacts to water quality and aquatic resources.

Compliance with the CPS SWPPP and BMPs in the construction stormwater permit would also minimize potential spills and releases associated with the construction of the plant. Therefore, construction-related impacts on aquatic ecological resources would be SMALL.

During operations, the NGCC plant would require less cooling water intake than CPS, resulting in less impingement and entrainment. The NGCC plant would consume more water that CPS due to closed-cycle cooling, but the impacts of water use to the Clinton Lake resource are expected to be small. The NGCC plant would also require an NPDES permit that would be protective of water quality and aquatic resources. Operations-related impacts on aquatic ecological resources would be SMALL.

Special Status Species

The NGCC plant would not require a federal permit except for construction in or along a waterway or in wetlands, so the federal action for review of the potential for impacts to protected species would be limited. However, IEPA regulations for a construction stormwater permit requires a review for protected species in the form of an IEPA approval letter facilitated by IEPA's online EcoCAT (IEPA 2023).

As presented in Section 3.7.8, federally listed threatened or endangered species possibly occurring within a 6-mile radius of CPS include the Indiana bat, northern long-eared bat, Eastern Massasauga rattlesnake, rusty patched bumble bee, and eastern prairie fringed orchid. Additionally, the monarch butterfly is federally listed as a candidate species.

Section 3.7.8.2 presents two additional terrestrial species, the northern harrier and the Kirtland's snake, which are state listed as endangered and threatened, respectively. According to IEPA's online EcoCAT system, these species may be in the 6-mile radius of CPS. In addition, these aquatic species; spike mussel, American brook lamprey, and monkeyface mussel have the potential to be in DeWitt County but have not been observed in Clinton Lake.

Construction at the CPS site would require tree removal and USFWS guidance regarding nesting and roosting trees would be followed. Tree removal would require adherence to practices that avoid take of the northern long-eared bat and the bald eagle, or if take cannot be avoided, take permits for one or both species would be required. To avoid take of the bald eagle, timber harvesting operations would avoid clear-cutting within 330 feet of active or inactive nests at any time and avoid encroaching within 660 feet of an active nest during nesting season

(USFWS 2019). Clearing of terrestrial habitat for the extension of the natural gas transmission lines, which would occur both on and off site, would also be required and would cause similar impacts as the NGCC plant construction.

For construction in or along waterways such as the construction of new or modified intake and discharge structures or for dredging, a CWA Section 404 permit would be required. The application would require information on protected aquatic species and the potential for impacts from the project. The permit conditions would require measures to minimize impacts to protected species. Use of a closed cycle cooling system and compliance with a state issued NPDES permit would minimize impacts to aquatic species from impingement and entrainment and impacts to water quality during operations.

If take of a federally protected species is anticipated, a take permit would be required. The USFWS would issue a take permit after it has ensured a variety of safeguards and determined that authorizing the activity would not jeopardize the continued existence of the species or destroy its habitat. A Habitat Conservation Plan must accompany the take permit application. As presented in Section 3.7.8, suitable habitat exists on site particularly in the wooded areas; however, no federal listed species have recorded occurrences within a 1-mile radius of the CPS site. Thus, construction and operation of a NGCC plant at the CPS site MAY AFFECT but is NOT LIKELY to ADVERSELY AFFECT federally listed species.

As discussed in Section 3.7.8, the CPS has suitable habitat for various state listed species. Overall, the construction and operation of a NGCC plant at the CPS site would have a SMALL to MODERATE impact on special status species.

7.2.3.1.8 Historic and Cultural Resources

The NGCC plant would be sited on the former ESP site, and the potential exists for impact to cultural sites. Previous cultural resource identification efforts indicate the presence of several archaeological sites and the potential for additional sites (NRC 2006). However, there are no NRHP listed, or eligible cultural resources confirmed within the CPS property. The NGCC would not require the full acreage considered in the ESP allowing for the opportunity to avoid archaeological sites. The IEPA stormwater permit requires a SHPO letter of approval, thus recorded cultural sites could be avoided at the CPS site as well as for the natural gas pipeline extension. However, in the absence of a required NHPA Section 106 consultation, further investigation of the site would not be required. Therefore, construction of the NGCC plant could have NO EFFECT or ADVERSE EFFECT on cultural resources.

7.2.3.1.9 Socioeconomics

Socioeconomic Issues other than Transportation

The project timeline of planning, procurement, and construction duration would be 2-3 years. The peak construction workforce would be about 1,200 and would likely be primarily from the surrounding area rather than relocation (NRC 2019b). Construction would have beneficial economic impacts in the area by creating direct and indirect jobs and incomes, increasing purchases of goods and services, and generating tax revenues. The workforce would also result in additional pressure on local temporary housing, community services, and infrastructure. Given the peak workforce size and duration of the project, both the beneficial and adverse socioeconomic impacts would likely be SMALL for Dewitt County.

The operations workforce for a NGCC plant located at the CPS site would be 150 workers (NRC 2019b) and would provide beneficial SMALL long-term socioeconomic impacts to DeWitt County.

Transportation

The temporary construction workforce at its peak would likely be noticeable and could cause congestion on roadways in the proximity of the construction site. To reduce congestion, staggered work shifts for construction could be implemented. The much smaller operations workforce would not have these congestion impacts and would be assigned to work shifts. The socioeconomic impacts of the NGCC alternative would be SMALL to MODERATE for construction and SMALL for operations.

7.2.3.1.10 Human Health

Impacts on human health from construction of an NGCC plant and extension of natural gas transmission lines would be similar to those associated with a large industrial facility construction project. Worker safety would be addressed by following the OSHA worker protection standards. The radiological human health impact on construction and operations workers due to working in proximity to operating and then decommissioning CPS would be SMALL due to compliance with NRC regulations and adherence to ALARA principles. Operation of an NGCC plant would also have similar impacts to CPS and would be in compliance with OSHA standards.

Human health impacts from the operation of the NGCC plant would primarily be from air pollutant emissions. The NGCC plant would emit criteria air pollutants (Table 7.2-1). Some pollutants, such as NO_x, contribute to ozone formation, which can create health problems. These criteria pollutants are regulated, and technology would be installed in the plant to limit the criteria air pollutant releases.

Overall, with application of pollutant controls and compliance with air quality standards and compliance with OSHA worker safety standards, operations-related impacts to human health under the NGCC alternative would be SMALL to MODERATE.

7.2.3.1.11 Environmental Justice

Potential impacts from construction of an NGCC plant and extension of natural gas transmission lines would primarily be associated with socioeconomic effects. These impacts would consist of the short-term beneficial impacts from an increase in worker expenditures at local businesses and short-term adverse impacts from rental housing shortages and traffic congestion during the construction phase of the project. Environmental and socioeconomic impacts would be minor and would not be expected to result in disproportionately high and adverse effects to low income and minority communities.

The activities associated with the operating plant would be similar to those at CPS with the exception being air emissions if the NGCC was sited at CPS. As presented in Section 7.2.3.1.3, air quality impacts from a NGCC plant would be MODERATE. However, because emissions are expected to remain within regulatory standards, impacts from emissions are not expected to be high and adverse. Sections 3.11.2.2 and 3.11.2.3 present the minority and low-income populations in the region surrounding the CPS site. The closest identified minority population is located 18.4 miles north-northwest of the CPS center point. The closest low-income block group that meets the guidance criteria for individuals or families is located 19.2 miles south-southwest of the CPS reactor. No disproportionately high and adverse effects would be expected for minority or low-income communities.

7.2.3.1.12 Waste Management

Solid, liquid, and gaseous waste generated during the construction of the NGCC plant and extension of natural gas transmission lines would be handled according to county, state, and federal regulations, and disposed of at permitted offsite treatment or disposal facilities. Therefore, construction-related waste impacts would be SMALL.

Operation of the NGCC plant would result in waste from spent catalytic reduction catalysts used to control nitrous oxide emissions. This waste stream is considered hazardous and would be disposed of at a facility that handles hazardous materials. Other waste generated at the site would be characterized as hazardous or non-hazardous. The non-hazardous and hazardous waste would be managed in compliance with state regulations and disposed of in permitted facilities. CEG would implement recycling and waste minimization programs that would reduce waste volumes. The waste impacts from operations would be SMALL given CEG's compliance with regulations, use of permitted facilities, and implementation of effective practices for waste minimization.

7.2.3.2 Renewable and Natural Gas Combination Alternative

The renewable and natural gas combination alternative relies on renewables for approximately one-third of the generation with the remaining generation coming from natural gas. Renewables in current use by utilities (wind, solar, hydropower, biomass) require vast amounts of land for generation or fuel sources (Section 7.2.2). To replace the 1,080 MWs provided by CPS with just renewables would require acreages far beyond that of a natural gas alternative and for that resource area alone would not be a reasonable comparative alternative to the proposed action to support NEPA decision-making. Including natural gas generation in the combination minimizes land use conversion because the plant can be located at the CPS site and the abundant natural gas supply in the United States eliminates the need for more acreage to be converted for new natural gas wells. Using the CPS site for natural gas-fired generation continues to provide tax revenue and employment for DeWitt County. Further, natural gas is a cleaner burning fuel than biomass fuels and would operate under strict emission regulations. The balanced renewable and natural gas combination alternative includes an NGCC plant, solar PV installations, and onshore wind installations all located at the CPS site as follows:

- 870MW (net) NGCC plant with MDCTs
- Onsite solar installation (216 MWs) with battery storage to make it baseload.
- Onsite wind installation (652 MWs) with battery storage to make it baseload.

To yield approximately 870 MWe net, the size of the NGCC plant component would be 1,000 MWe (gross) based on an Energy Information Administration (EIA) capacity factor of 0.87 (EIA 2022b). Solar generation has a much lower capacity factor to account for nighttime hours and daytime hours with varying solar irradiation. Each installed solar MW would yield approximately 2,190 MWh of generation annually using a 25 percent capacity factor. The solar panels would be supported with onsite lithium-ion battery storage to provide firm generation. The onsite solar installation would be 216 MW providing approximately 5 percent of CPS's net generation. Wind generation in 2014-2019 has an average generation capacity of 41.4 percent (DOE 2021a). Using this capacity factor, 1 MW installed wind generation would provide approximately 3,627 MWh of generation annually. The 652 MW of wind generation would provide approximately 25 percent of CPS's net generation.

7.2.3.2.1 Land Use

The NGCC component of the renewable and natural gas combination alternative is 65 percent the size of the NGCC discrete alternative. The renewable and natural gas combination alternative NGCC plant would be sited within the same construction footprint as the discrete NGCC alternative, requiring less overall acreage. The plant would require clearing of a smaller acreage, reducing the impact of terrestrial habitat removal. Therefore, the land use impacts for the NGCC plant component would be bounded that of the NGCC alternative described in Section 7.2.3.1.1 and would be SMALL for construction and operation.

The construction acreage of 1,130 needed for wind, could be satisfied by clearing the available acreage and installing the wind turbines first and then installing the solar among the wind turbines with appropriate spacing.

As discussed in Section 7.2.2.1.4 and 7.2.2.1.5, solar and wind facilities require large areas of land to generate electricity. The wind turbines would be spaced as appropriate, allowing the wind and solar installations to be co-located on the CPS site. Using 7.5 acres per MW would require a total of approximately 1,620 acres for the onsite solar installation. As presented in Section 7.2.2.1.4, wind installation land requirements have three metrics: farm boundary, construction footprint, and permanent structures. The permanent structures of the wind component would occupy approximately 480 acres and the construction footprint inclusive of the permanent structures would be 1,610 acres. The acreage for both solar and wind totals to 3,230 acres. Figure 7.2-1 shows the potential areas on the CPS site where alternative generation could be sited which excludes the Clinton Lake State Recreation Area and uncleared shoreline areas, an acreage of approximately 2,850 acres, which is less than the 3,230 acres for both solar and wind. To overcome this shortfall, installation of the wind turbines and solar panels would be coordinated, allowing the construction footprint of each to overlap, minimizing the overall needed acreage. For instance, clearing for the wind turbines first would provide acreage to support construction of the wind turbines with the completed wind installation only occupying 480 acres, leaving 2,370 acres available for installation of the solar panels.

As presented in Section 3.2.1, the CPS site outside of the power generation portion is zoned primarily as a Rural Development District – 2 with a small area zoned as a Rural Development District – 1. DeWitt County Ordinance Title XV, Chapter 153 addresses wind development and Chapter 157 addresses solar development. These ordinances allow solar and wind development in only areas zoned Agricultural and RD-1. So, use of the CPS site for solar and wind generation would require a zoning change.

The wind and solar development would also require a conversion of the land use. Portions of the site are currently leased to the IDNR for conservation and the Clinton Lake State Recreation Area. Conversion from current zoning designation, converting land from conservation usage, and impacting a public recreation area due to proximity would be a MODERATE land use impact.

7.2.3.2.2 Visual Resources

Visual impacts from the NGCC plant component of the renewable and natural gas combination alternative would be essentially the same as those described for the discrete NGCC alternative in Section 7.2.3.1.2.

The solar panels could be visible to the public from offsite locations, depending on buffer areas or screening. DeWitt County Ordinance Title XV, Section 157.08 addresses large scale solar farms and requires setbacks of up 500 feet from residential lots and screening such as an evergreen hedge can be required.

The wind turbines of each wind installation would be visible from all directions. In addition, the rotating blades of wind turbines cast moving shadows on the ground and on structures, causing a shadow flicker phenomenon. Shadow flicker is considered a nuisance rather than a human health hazard and the potential impact of shadow flicker can be mitigated by setback distances from structures, vegetative buffers, or the curtailment of the turbine during times of highest impact (DOE 2015). DeWitt County Ordinance Title XV, Chapter 153 addresses commercial wind farms and requires a shadow flicker study be conducted as part of the approval process.

The turbines would be marked and lighted according to FAA guidelines, which call for painting the turbines and towers white or light gray, while making them highly visible to pilots from the air. Aviation red flashing, strobe, or pulsed obstruction lights would be mounted atop selected turbines and at the end of each turbine string or within and around the perimeter such that the gap between lights is no greater than 0.5 miles, allowing the entire facility to be perceived as a single unit by pilots flying at night. The specific location of aviation lighting and the operation of the lighting system would be determined in consultation with FAA. (FAA 2018) In addition, the DeWitt County ordinance for wind development requires the most efficient system approved by FAA to be utilized.

The solar panels, wind turbines, and NGCC stacks would be visible from portions of the Clinton Lake State Recreation Area. Regardless of the DeWitt County ordinance mentioned above requiring setbacks of 500 feet, visual cover from trees and other vegetation, and siting that would take visual impacts into consideration, the Clinton Lake State Recreation Area shares a considerable border with the CPS property meaning visual impacts are unavoidable. Overall, the visual impacts from the construction and operation of the renewable and natural gas combination alternative would be MODERATE.

7.2.3.2.3 Air Quality

The impacts on air quality due to construction and operation of the NGCC plant would be similar to those associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.3 and would be SMALL for construction related impacts and MODERATE for operational impacts. The estimated criteria air pollutant and CO_2 emissions are presented in Table 7.2-1.

Construction activities associated with the solar and wind installations would generate fugitive dust. Mitigation would be implemented via wetting of cleared areas and dirt roads to minimize the fugitive dust. Construction equipment and vehicles would also emit exhaust emissions. These emissions would be temporary and mitigation such as curtailing idling of vehicles would be implemented to minimize short-term air quality impacts. Even with the implementation of mitigation measures, given the acreage to be cleared at CPS, nearby offsite areas could experience noticeable, temporary impacts to air quality. Construction emissions associated with the solar and wind components of the renewable and natural gas combination alternative would be SMALL to MODERATE. The solar and wind components of the renewable and natural gas combination alternative would not release air emissions during operation.

Overall, the air quality impacts from the construction of the renewable and natural gas combination alternative would be SMALL to MODERATE, and operations would be MODERATE for the NGCC component.

7.2.3.2.4 Noise

The construction and operation of the NGCC plant component of the renewable and natural gas combination alternative would have noise impacts similar to those described in the discrete NGCC plant alternative presented in Section 7.2.3.1.4 and would be SMALL.

Construction of each solar and wind installation would likewise have noise impacts similar to those described in the discrete NGCC plant alternative presented in Section 7.2.3.1.4 with a shorter duration. However, given the acreage of the solar installations and the potential need for land clearing and the number of turbines that would need to be installed, noise impacts would range from SMALL to MODERATE and be temporary for the duration of construction of each facility.

No noise impacts would occur from operation of a solar installation. During operations, the wind turbines would emit sound. Turbine sound is typically one of the greatest nuisance impacts associated with wind power. The DOE addressed this concern with a review of the available data and research on impacts to human health, concluding that as of 2013, global peer-reviewed scientific data and independent studies consistently concluded that sound from wind plants has no direct impact on physical human health. (DOE 2015) The DeWitt County ordinance for wind development introduced in Section 7.2.3.2.2 sets a noise limit of 50 dBA measured as the average dBA at the location of the nearest offsite residence.

Overall, construction-related noise impacts associated with renewable and natural gas combination alternative is dependent on the site selected and proximity to residents and other sensitive receptors and would range from SMALL to MODERATE. Operations-related noise impacts associated with the renewable and natural gas combination alternative would be SMALL.

7.2.3.2.5 Geology and Soils

The impact on geology and soils due to construction and operation of the NGCC component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.5 and would be SMALL.

Construction impacts to geology and soils resulting from the construction of the solar and wind installations and supporting transmission lines would primarily be impacts to soils from clearing and grubbing. These temporary soil impacts would be minimized by implementation of BMPs. Geological impacts would be minor, as any gravel or stone used in the construction of roads and infrastructure would be sourced from local businesses that sell materials sourced from local quarries. During operations, the solar and wind installations would be required to have a NPDES construction stormwater permit and comply with IEPA regulations to control stormwater runoff.

Overall, the geology and soil impacts from the construction and operation of the renewable and natural gas combination alternative would be SMALL.

7.2.3.2.6 Hydrology (Surface Water and Groundwater)

The impact on surface water and groundwater use and quality due to constructing and operating the NGCC plant component would be similar to that associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.6 and would be SMALL for construction and for operation.

Construction of the solar and wind installations would require water for dust suppression, equipment washing, and sanitary systems. The solar and wind installation would not have process water needs for operation, but water would be needed for periodically washing the solar panels. The water demand could be met by trucked-in water or onsite or nearby surface or groundwater resources. CEG would utilize the most practical supply and comply with any required water withdrawal permits and applicable regulations. Water quality impacts could result from erosion and runoff associated with the construction of the solar and wind installations. These temporary soil impacts would be minimized by implementation of BMPs and compliance with stormwater permits and applicable regulations. Groundwater would be protected through the implementation of stormwater controls and spill prevention measures. Once in operation, CEG would operate the installations in compliance with stormwater regulations. The use and water quality impacts for both surface water and groundwater resources associated with the construction and operation of the solar and wind installations would be SMALL.

Overall, the impacts to surface water resources from the construction and operation of the renewable and natural gas combination alternative would be SMALL. Overall, the impacts to groundwater resources for the renewable and natural gas combination alternative would be SMALL.

7.2.3.2.7 Ecological Resources (Terrestrial and Aquatic)

Terrestrial

As with the discrete NGCC plant alternative, the NGCC plant component of the renewable and natural gas combination alternative would be constructed in the same footprint as the NGCC discrete alternative. The impact on terrestrial resources due to construction and operation of the NGCC plant component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.7 and would be SMALL for construction and operations.

Terrestrial ecology impacts from the construction of solar and wind installations would result from clearing approximately 1,620 acres for the solar components and 1,610 acres for the wind components, much of which is likely to be providing terrestrial habitat. CEG would follow USFWS guidance for land-based wind energy development and eagle conservation (USFWS 2012; USFWS 2013). The guidance focuses on "species of concern" and addresses loss and degradation/fragmentation of habitat. Therefore, terrestrial ecology impacts associated with the solar and wind components of the renewable and natural gas combination alternative would be MODERATE given the large land requirement and the conversion of the site from conservation use.

No operational impacts to terrestrial ecological resources would occur from the solar component of the renewable and natural gas combination alternative. The operation of the wind turbines could affect avian and bat species. Following USFWS guidance for siting would minimize impacts and compliance with any incidental take permits would minimize impacts to special status species. Mortality rates for birds at land-based wind plants average between three and five birds per MW per year, and no plant has reported an average greater than 14 birds per MW per year, with common songbirds accounting for approximately 60 percent of all bird collision mortality (DOE 2015). Those mortality levels for the 61 gigawatt of wind capacity installed in

2013 at the time of DOE’s study constitute a very small percentage, typically <0.02 percent, of the total populations of those songbird species (DOE 2015). Using the annual average of five bird deaths per MW, operation of the wind component of the renewable and natural gas combination alternative would result in an estimated 3,260 bird deaths per year of operation.

Overall, the ecological impacts to terrestrial species from construction and operation of this alternative would be MODERATE primarily due to the acreage disturbed and permanent terrestrial habitat removal.

Aquatic

The NGCC component would use the same cooling water intake and discharge configuration as the discrete NGCC alternative. The renewable and natural gas combination alternative NGCC plant would be about 65 percent the size of the discrete alternative and therefore use less cooling water. The impact on aquatic resources due to constructing and operating the NGCC plant component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative presented in Section 7.2.3.1.7.

Impacts to aquatic resources resulting from the construction of the solar and wind components of the renewable and natural gas combination alternative would be minimized by the implementation of BMPs to control erosion and run-off. No operations-related impacts to aquatic resources are associated with the solar and wind components of the renewable and natural gas combination alternative.

Therefore, the ecological impacts to aquatic species from the construction and operation of the renewable and natural gas combination alternative would be SMALL.

Special Status Species

The NGCC plant component of the renewable and natural gas combination alternative would be constructed within the same area as the discrete NGCC alternative, requiring clearing of terrestrial habitat that is not of high quality given its proximity to the existing generation facility. As presented in Section 3.7.8, no federal listed species have recorded occurrences within a 1-mile radius of the CPS reactor. Construction and operation of a NGCC plant at the CPS site MAY AFFECT but is NOT LIKELY to ADVERSELY AFFECT federally listed species.

As presented in Section 3.7.8, federally listed threatened or endangered species possibly occurring within a 6-mile radius of CPS include the Indiana bat, northern long-eared bat, Eastern Massasauga rattlesnake, rusty patched bumble bee, and eastern prairie fringed orchid. Additionally, the monarch butterfly is federally listed as a candidate species.

Section 3.7.8.2 presents two additional terrestrial species, the northern harrier and the Kirtland’s snake, which are state listed as endangered and threatened, respectively. According to IEPA’s online EcoCAT system, these species may be in the 6-mile radius of CPS. In addition to these aquatic species, spike mussel, American brook lamprey, and monkeyface mussel have the potential to be in DeWitt County but have not been observed in Clinton Lake.

Tree removal would require adherence to practices that avoid take of the northern long-eared bat and the bald eagle, or if take cannot be avoided, take permits for one or both species would be required. To avoid take of the bald eagle, timber harvesting operations would avoid clear-cutting within 330 feet of active or inactive nests at any time and avoid encroaching within 660 feet of an active nest during nesting season (USFWS 2019). CEG would also follow USFWS guidance for land-based wind energy development and eagle conservation (USFWS 2012; USFWS 2013). The guidance focuses on "species of concern" and addresses loss and degradation/fragmentation of habitat. The IEPA stormwater permit requires an IEPA EcoCAT letter of approval.

Given avoidance, minimization, and mitigation measures, and compliance with applicable permits, the renewables and natural gas combination alternative MAY AFFECT but is NOT LIKELY to ADVERSELY AFFECT federally listed species.

7.2.3.2.8 Historic and Cultural Resources

The impact on historic and cultural resources due to constructing the NGCC plant component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative presented in Section 7.2.3.1.8 and would be NO EFFECT or impacts could be ADVERSE EFFECT.

The IEPA stormwater permit requires a SHPO letter of approval, thus recorded cultural sites can be avoided. As noted in Section 4.7.4.2, there have been 17 previous cultural resource surveys within the CPS property, which identified 172 archaeological entries, three cemeteries, and no NRHP eligible cultural resources. The potential exists for impact to these and/or additional unidentified historic and cultural resources associated with the development of solar and wind installations in portions of the CPS site that has not been investigated. Impacts to historic and cultural resources could range from NO EFFECT to ADVERSE EFFECT, depending upon the placement of the facilities.

7.2.3.2.9 Socioeconomics

Socioeconomic Issues other than Transportation

The construction and operation of the NGCC component of renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative presented in Section 7.2.3.1.9 and the beneficial and adverse socioeconomic impacts would likely be SMALL for DeWitt County.

The construction and operation of the solar and wind components of the renewable and natural gas combination alternative would create fewer construction jobs than the NGCC plant. Any boost to the DeWitt County economy would be short in duration, and socioeconomic impacts related to the construction of renewable and natural gas combination alternative would be SMALL.

In addition to the NGCC plant staff, between 4 to 12 workers would be required to maintain the onsite solar installations, as estimated from the socioeconomic impacts of other solar projects (TVA 2019, TVA 2021a, TVA 2021b). The solar installation and the property occupied by the wind turbines could be taxed at a higher rate than agricultural land, providing a tax benefit.

Overall, the socioeconomic impacts from the construction and operation of the renewable and natural gas combination alternative would be SMALL.

Transportation

Transportation impacts during the construction and operation of the NGCC plant would be similar to those associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.9. The development of the wind and solar installation would increase traffic on local roads during construction, but the small workforce needed for the operations would not noticeably increase the impact of the NGCC component. Overall, the transportation impacts associated with construction of the renewable and natural gas combination alternative would be SMALL to MODERATE. The impacts during operation would be expected to be SMALL.

7.2.3.2.10 Human Health

Impacts on human health from construction and operation of the NGCC component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative presented in Section 7.2.3.1.10 and would be SMALL for construction and SMALL to MODERATE for operations.

During construction of the solar and wind installations, worker safety would be addressed by following the OSHA worker protection standards. Therefore, construction-related impacts on human health under the solar and wind components of the renewable and natural gas combination alternative would be SMALL. As mentioned in Section 7.2.3.2.4, regarding wind turbine noise, the DOE concluded that sound from wind plants has no direct impact on physical human health. (DOE 2015)

Therefore, the human health impacts associated with the construction of the renewable and natural gas combination alternative would be SMALL and range from SMALL to MODERATE for operations.

7.2.3.2.11 Environmental Justice

Potential impacts on minority and low-income populations from construction and operation of the NGCC component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative discussed in Section 7.2.3.1.11. The construction and operation of the solar and wind components of the renewable and natural gas combination alternative at the CPS site would also be unlikely to have disproportionately high and adverse human health and environmental effects on minority and low-income populations due to distance to these populations, as well as the temporary nature of construction impacts. Overall, the renewable and natural gas combination alternative is expected to have no disproportionately high and adverse human health and environmental effects on minority and low-income populations.

7.2.3.2.12 Waste Management

Impacts on waste management from construction and operation of the NGCC component of the renewable and natural gas combination alternative would be similar to those associated with the discrete NGCC plant alternative presented in Section 7.2.3.1.12 and would be SMALL.

The construction of the solar and wind installations would create land clearing waste disposed of on site or shipped to an offsite construction debris landfill. The construction of the solar and wind installations would create sanitary, and industrial waste in smaller quantities than the NGCC plant. This waste would be recycled, disposed of on site, or shipped to an offsite waste disposal facility. The operation of each solar and wind installation is expected to generate very minimal waste from daily operations. The battery storage system at each solar installation would have to be replaced after several years of operation; however, much of the components are recyclable, minimizing the waste generation. Solar developers are currently assuming lifespans for solar panels to be 30 years or more (LBNL 2020). Wind turbine manufacturers are generally indicating that current designs have a 30-year lifespan (LBNL 2019). As a good environmental steward, CEG would implement waste management practices to recycle or dispose of all waste generated at the installations at an offsite waste disposal facility. Therefore, waste management impacts from daily operations of the solar and wind installations would be SMALL.

Overall, the waste management impacts from the construction and operation of the renewable and natural gas combination alternative would be SMALL.

7.2.3.3 Purchased Power

Replacing all energy generation and capacity provided by CPS with purchased power would introduce greater uncertainties in energy reliability that are not within CEG's control. Further, purchased power would be subject to competing power demand to secure firm power contracts adding to energy reliability concerns. The closure of coal-fired plants across the United States also changes the availability of baseload generation further introducing uncertainty for purchasing firm energy supply. In addition, long-term purchase agreements of power would have to be in accordance with the Illinois PAA (20 ILCS 3855 Section 1-75) as amended by the CEJA which focuses on renewable power (ICC 2022).

Potential environmental impacts associated with purchased power could be substantial and exceed the impacts associated with the continued operation of CPS. Potential environmental impacts associated with purchased power would include those associated with the source of the generation and the transmission of the power into the regional grid. Fossil fuel generation results in air emissions, water use and quality issues, and land use impacts associated with the plant footprint. Renewable energy generation can have a large development footprint that can convert natural habitats to an industrial site. The conversion of forest and even agricultural lands to an industrial site can result in impacts to habitat that may adversely impact wildlife and plant species. Additional transmission capacity may be required to distribute electricity from renewable or fossil fuel generation and this may result in impacts to communities and lands within and adjacent to the corridor. These impacts could include loss of sensitive habitat, visual and view shed impairment, and degradation of wetlands and stream crossings.

The impacts of offsite generation cannot be specifically described, as the generation source is undefined. Offsite generation will be discussed in general terms for each potential impact category of the purchased power alternative.

Transmission of power into the regional grid could include construction of new transmission lines, substations and/or power synchronization equipment. The following discussion focuses on general impacts from construction of new transmission lines, separate from the potential impact of offsite generation.

7.2.3.3.1 Land Use

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois would have little direct land use impact. However, purchased power would have an impact where generated. Depending upon the type of energy imported, local zoning regulations and land use planning, and the facility's environs, land use impacts would be SMALL to MODERATE.

Transmission

Disturbance of additional land could be required for connection of purchased power generation sources outside of CPS's service area. This clearing of habitat, and soil disturbance, could have a SMALL to MODERATE land use impact, based on the distance of the power source and the amount of reuse of existing transmission infrastructure.

7.2.3.3.2 Visual Resources

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact visual resources where the generation facilities are located. Depending upon the type of energy imported, local setback and zoning regulations, and the facility's environs, visual impacts could be SMALL to LARGE.

Transmission

The visible impact of the transmission lines for the purchased power would not appear any different than existing transmission lines. Long-term transfers of utility-scale power from outside of a give power plant's region may require modification of one or more existing transmission grid segments (as well as modifications to substation and power synchronization equipment) and could require construction of new transmission line segments. (NRC 2013a)

When possible, existing utility corridors would be utilized, and the path of newly constructed transmission lines would avoid impacting scenic areas such as U.S. Congress-designated areas for protection of unique natural, cultural, and recreational values (e.g., national scenic and historic trails, national historic landmarks, scenic areas, recreation areas, preserves, and monuments). Avoiding impacts on the most scenic viewsheds would reduce the most significant visual impacts, allowing the impact to be minimized. Overall, the visual impacts from the construction of transmission infrastructure required for the purchased power alternative would be SMALL.

7.2.3.3.3 Air Quality

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact air quality where the generation facilities are located. Depending on the type of energy imported, local air quality regulations, and the facility's environs, the air quality impacts from operations could be SMALL to MODERATE. If the use of purchased power requires construction of new generating facilities, the construction activities and vehicle emissions would have temporary, SMALL impacts on local air quality reduced by implementation of BMPs.

Transmission

Construction activities associated with construction of additional transmission lines and/or modification of existing transmission lines would generate fugitive dust. Mitigation would be implemented via wetting of cleared areas and dirt roads to minimize the fugitive dust. Construction equipment and vehicles would also emit exhaust emissions. These emissions would be temporary and mitigation such as curtailing idling of vehicles would be implemented to minimize short-term air quality impacts. Excess dust is not expected to be an air quality issue, however dust suppression measures could be implemented in areas of concern, should these concerns arise. The air quality impacts from the construction/modification of transmission lines for the purchased power alternative would be SMALL.

7.2.3.3.4 Noise

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact sensitive noise receptors where the generation facilities are located. Depending upon the type of generation, local setback and zoning regulations, and the facility's environs, noise impacts could be experienced by sensitive receptors and likely range from SMALL to MODERATE.

Transmission

Construction-related noise impacts associated with the construction of transmission lines are possible depending on the location of the purchased power generation. Sources of noise during construction could include clearing, earthmoving, and installation of equipment/lines. BMPs would be implemented, and local and state noise regulations would be followed to reduce temporary noise disturbance. Construction activities resulting in offsite sound levels above this range would be temporary and SMALL.

7.2.3.3.5 Geology and Soils

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside the state of Illinois could impact the geology and soils where the generation facilities are located, specifically if additional construction is required. If additional construction is required, these soil impacts would be temporary and minimized by implementation of BMPs. Depending upon the type of generation, construction needs, and the facility's environs, impacts to geology and soils are likely to be SMALL.

Transmission

Impacts to geology and soils resulting from the modification of one or more existing transmission grid segments, modifications to substation and power synchronization equipment, and/or construction of new transmission line segments could occur.

This would primarily be impacts to soils from clearing and grubbing. These temporary soil impacts would be minimized by implementation of BMPs. Geological impacts would be minor, as any gravel or stone used in the construction of temporary roads for this construction would be sourced from local businesses that sell materials sourced from local quarries. Overall, the geology and soil impacts from the construction of transmissions lines for the purchased power alternative would be SMALL.

7.2.3.3.6 Hydrology (Surface Water and Groundwater)

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact surface water and groundwater where the generation facilities are located. Potential impacts include the alternation of drainage features that convey runoff due to clearing of vegetation. The impacts from drainage alterations would be minimized by the implementation of BMPs. Hypothetical accidental releases of oil or other chemicals being used could contaminate runoff and subsequently nearby waterbodies. This could be prevented by adherence to stormwater permits and regulations. Depending on the type of energy imported, local regulations, and facility's environs impacts to surface water and groundwater could be SMALL to MODERATE.

Transmission

Construction of supporting transmission lines for the purchased power alternative would require water for dust suppression, equipment washing, and sanitary systems. CEG would utilize the most practical supply and comply with any required water withdrawal permits and applicable regulations. Water quality impacts could result from erosion and runoff associated with the construction of these transmission lines. These temporary impacts would be minimized by implementation of BMPs and compliance with stormwater permits and applicable regulations. The hydrological impacts of this construction would be SMALL.

7.2.3.3.7 Ecological Resources (Terrestrial and Aquatic)

Terrestrial

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact terrestrial ecology where the generation facilities are located. Depending on the type of energy imported, impacts to terrestrial ecology would be nearly all attributable to land clearing and habitat removal during construction which would range from SMALL to LARGE depending on the land required and site-specific environs, with impacts attributable to operations being SMALL.

Transmission

Terrestrial ecology impacts from the construction of transmission lines would primarily result from land clearing, noise, and emissions from construction equipment. Siting considerations for these transmission lines would avoid wetlands and other high-quality terrestrial habitats such as critical habitat for threatened and endangered species and habitats identified as a priority for preservation. Transmission corridor maintenance would be used on the ROW. The overall impact of construction-related activities and operations on terrestrial ecological resources would be SMALL.

Aquatic

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact aquatic ecology where the generation facilities are located due to construction and industrial activities and stormwater run-off. Depending on the type of energy imported, impacts to aquatic resources would result from surface water intake and discharge, and would be SMALL to MODERATE.

Transmission

The implementation of BMPs to control erosion and run-off during transmission line construction would reduce impacts to aquatic ecology. Therefore, the ecological impacts to aquatic species from the construction of transmission lines would be SMALL.

Special Status Species

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could impact special status species. The purchased power alternative would require minimal/no clearing of terrestrial habitat that is suitable for federally and state listed species when power is purchased from existing sources. Depending on the type of energy imported and whether new generation facilities must be constructed, impacts MAY AFFECT, but NOT LIKELY to ADVERSELY AFFECT special status species.

Transmission

Construction of transmission lines may be necessary depending upon the location of the purchased power generation. Construction of transmission lines for the purchased power alternative would require an EcoCAT approval letter for the construction stormwater permit, thus, siting would take into consideration of the presence of protected species. Thus, construction of the transmission lines MAY AFFECT but is NOT LIKELY to ADVERSELY AFFECT federally listed species.

7.2.3.3.8 Historic and Cultural Resources

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois is unlikely to impact historical and cultural resources if no new generation facility construction is necessary. However, if new construction is required, cultural resources could be impacted depending on local and state cultural reviews and preservation requirements. Cultural resource identification efforts at the site of any new construction would reduce and/or eliminate these potential impacts. The impact from new generation would be NO EFFECT to ADVERSE EFFECT.

Transmission

Development of transmission lines could impact cultural resources, depending on the siting location, however consideration would be taken to utilize existing transmission lines and construct new lines in areas that do not contain historic and cultural resources. Impacts to historic and cultural resources would likely be NO EFFECT.

7.2.3.3.9 Socioeconomics

Socioeconomic Issues other than Transportation

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois would cause socioeconomic impacts for the county where the power is generated. Employment for new construction as well as operations at the facilities supplying the purchased power would be outside of DeWitt County and would not impact the local economy. The impact to the economy where the generation facilities are located would be SMALL to LARGE beneficial impacts depending on the size of the local economy. Ongoing adverse impacts to the existing community infrastructure would likely be SMALL because the community would have had the opportunity to use the tax base provided by the power plant to expand community services as needed. If new construction is required, the adverse impacts would likely be SMALL to MODERATE depending on the existing community infrastructure and the beneficial impacts would be SMALL to LARGE depending on the size of the local economy.

Transmission

Development of transmission lines could have a temporary, SMALL beneficial impact to the local economy from construction material purchases and workers' purchases. However, due to the small size of the construction work force, which would likely be sourced from the local or regional area, no adverse impacts would be expected. Therefore, the operations-related socioeconomic impacts under the purchased power alternative would be SMALL.

Transportation

Offsite Generation

Purchased power imported from generating sources outside of CPS's service area and/or outside of the state of Illinois could have transportation impacts. Operation of the energy generation facility and transportation of workers to this facility would occur off site. Depending on the type of energy supported, transportation needs for operation would differ slightly, but likely be SMALL. If new construction is required, the impact to transportation would likely be SMALL to MODERATE depending on the existing transportation infrastructure.

Transmission

The size of the construction workforce and amount of equipment transported to the transmission line locations would be temporary and minimal, as efforts would be made to utilize existing infrastructure. Therefore, transportation impacts for construction of transmission lines under the purchased power alternative would be SMALL.

7.2.3.3.10 Human Health

Offsite Generation

Purchased power imported from generating sources outside of CPS’s service area and/or outside of the state of Illinois could impact human health where the generation facilities are located. Depending on the type of energy imported, local regulations, and the facility's environs, the human health impacts from operations could be SMALL to MODERATE. If new construction is required, compliance with OSHA regulations and state and local environmental regulations would allow the impacts to human health to be SMALL.

Transmission

During construction of transmission lines, worker safety would be addressed by following the OSHA worker protection standards. Therefore, construction-related impacts on human health under the purchased power alternative would be SMALL.

7.2.3.3.11 Environmental Justice

Offsite Generation

Purchased power imported from generating sources outside of CPS’s service area and/or outside of the state of Illinois could have potential impacts on minority and low-income populations where the generation facilities are located. The environmental justice impacts from new construction and operations of new and existing generation facilities would be dependent upon the type of the power generation facility, construction activities, and the proximity of minority and low-income populations. Therefore, the environmental justice impact is site-specific.

Transmission

Some minor environmental impacts would result during construction of transmission lines from fugitive dust, but this impact would be temporary and short in duration. Socioeconomic impacts on minority and low-income populations from transmission construction would consist of the short-term increase in worker expenditures at local businesses and potential rental housing shortages during the construction phase of the project. The temporary increase in traffic on roads would likely result in some small impacts to traffic that could affect local minority and low-income populations.

Overall, the transmission construction portion of the purchased power alternative is expected to have no disproportionately high and adverse human health and environmental effects on minority and low-income populations.

7.2.3.3.12 Waste Management

Offsite Generation

Purchased power imported from generating sources outside of CPS’s service area and/or outside of the state of Illinois could have potential waste management impacts where the generation facilities are located. Depending on the type of energy imported, local regulations, and the facility's environs the waste management impact from the operation of the purchased power alternative would be SMALL.

Transmission

Construction for the purchased power alternative would consist of transmission lines, if necessary, and would require smaller quantities of materials than other alternatives. Any sanitary/industrial waste created during these processes would be recycled, disposed of on site, or shipped to an offsite waste disposal facility. Overall, the waste management impacts from the construction of transmission lines of the purchased power alternative would be SMALL.

Table 7.2-1 Air Emissions Estimated for NGCC and Renewable and Natural Gas Combination Alternatives

Emission	NGCC Alternative (1,240 MWs) (estimated tons/year)[(b)]	Renewable and Natural Gas Combination Alternative NGCC plant (870 MWs) (estimated tons/year)[(b)]
Sulfur dioxide	114	87
Nitrogen oxides[(a)]	470	330
CO	1,100	760
Particulate matter 10 microns	240	168
Nitrous oxide	110	76
Volatile organic compounds	76	54
Carbon dioxide	4.0 million	2.8 million
a. Assumes 90 percent reduction in emissions due to operation of air pollution control equipment (selective catalytic reduction).		
b. Estimates based on EPA AP-42 emission factors. See formulas below.		

Formulas and Sources

Annual gas consumption (ft^3)	Plant size in MWe x heat rate x 1,000 x (1/ heat content) x hours in a year						
Heat rate = 6,654 British Thermal Unit to kilowatt-hour (Btu/kWh) (EIA 2020) Heat content of natural gas 2020 = 1,034 Btu/ft^3 (EIA 2022d)							
Annual MMBtu = (annual gas consumption x heat content)/1,000,000							
	CO_2	NO_x	CO	PM	SO_2	VOC	N_2O
Emission factor for processed natural gas (lbs/MMBtu)	110	0.13	0.03	0.0066	0.0034	0.0021	0.003
Annual emissions (tons) = (emission factor) x (annual MMBtu)/2000							
Air emission factors (EPA 2000)							

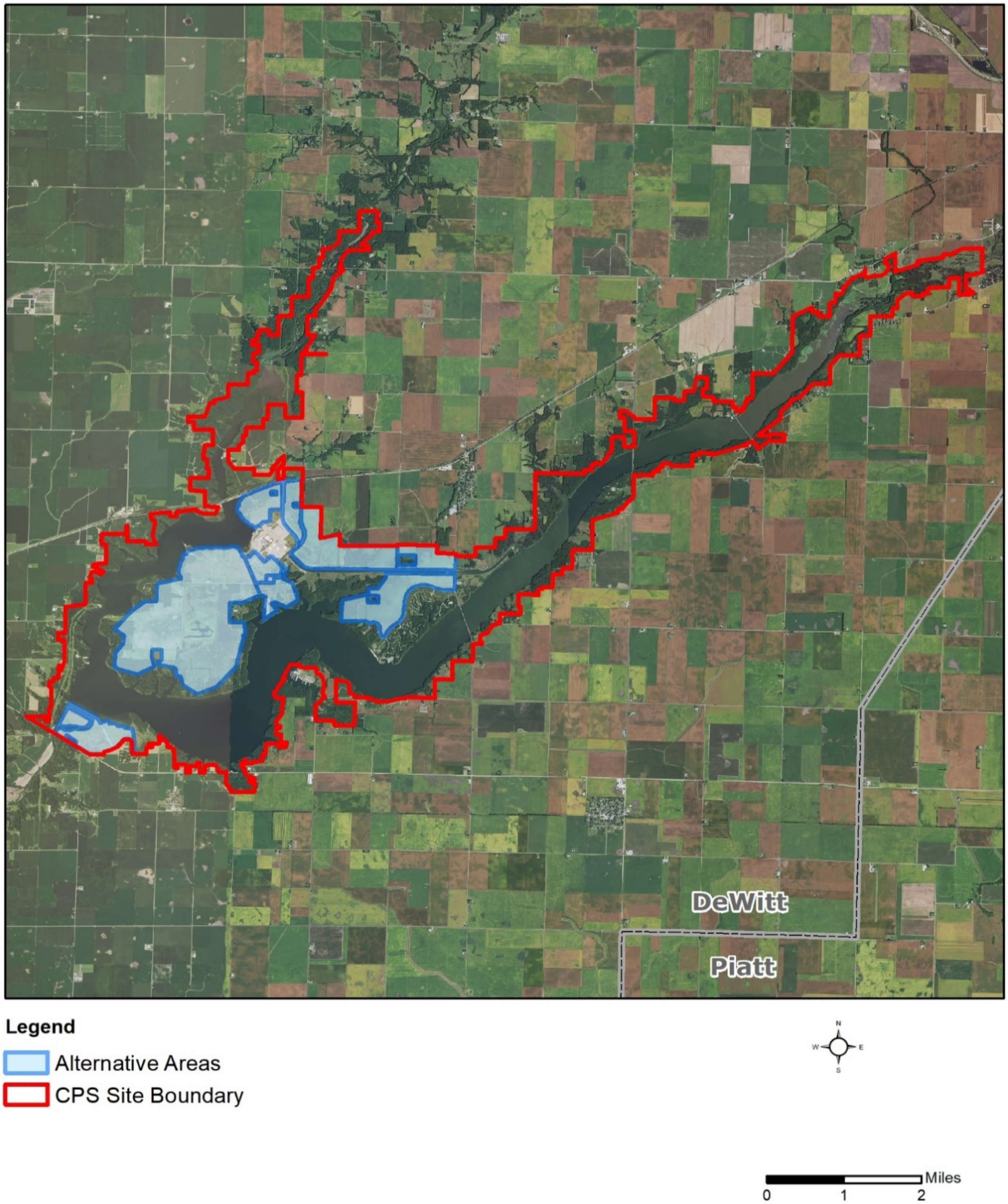


Figure 7.2-1 Potential Siting Area for Alternatives

7.3 Alternatives for Reducing Adverse Impacts

7.3.1 Alternatives Considered

As noted in 10 CFR 51.53(c)(3)(iii), "The report must contain a consideration of alternatives for reducing adverse impacts, as required by 51.45(c), for all Category 2 license renewal issues in Appendix B to Subpart A of this part." A review of the environmental impacts associated with the Category 2 issues in Chapter 4 identified no significant adverse effects that would require consideration of additional alternatives. Therefore, CEG concludes that the impacts associated with renewal of the CPS OL would not require consideration of alternatives for reducing adverse impacts as specified in NRC Regulatory Guide 4.2, Revision 1 (NRC 2013b). This determination assumes the existing mitigation measures discussed in Section 6.2 adequately minimize and avoid environmental impacts associated with operating CPS.

7.3.2 Environmental Impacts of Alternatives for Reducing Adverse Impacts

No additional alternatives were considered by CEG to reduce impacts because as determined in Chapter 4, the continued operation of CPS does not result in significant adverse effects to the environment.

8.0 COMPARISON OF THE ENVIRONMENTAL IMPACT OF LICENSE RENEWAL WITH THE ALTERNATIVES

To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form . . . . [10 CFR 51.45(b)(3)]

The proposed action is renewal of the CPS OL, which would preserve the option to continue to operate CPS to provide reliable baseload power and meet future generating demand throughout the proposed 20-year LR operating term. Chapter 4 provides analyses of the environmental impacts for the proposed action. The proposed action is compared to the no-action alternative, which includes both the termination of operations and decommissioning of CPS and reasonably foreseeable replacement of its baseload generating capacity. The termination of operations and decommissioning impacts are presented in the GEIS, Section 14.2.2, and decommissioning impacts are analyzed in the GEIS on decommissioning, NUREG-0586, Supplement 1 (NRC 2002; NRC 2013). The energy alternatives component of the no-action alternative is described, and its impacts analyzed in Chapter 7.

Table 8.0-1 summarizes the environmental impacts of the proposed action and the alternatives deemed reasonable for comparison purposes. Tables 8.0-2 and 8.0-3 provide a more detailed comparison. The environmental impacts compared in Tables 8.0-1, 8.0-2, and 8.0-3 are those that apply to the proposed action or issues that the GEIS identified as major considerations in an alternatives analysis.

In conclusion, there is no reasonable alternative that is environmentally preferable to the continued operation of CPS. All alternatives capable of meeting the needs currently served by CPS entail impacts greater than or equal to the proposed action of CPS LR. The continued operation of CPS would create significantly less environmental impact than the construction and operation of new alternative generating capacity. In addition, the continued operation of CPS would have a superior positive economic impact on DeWitt County through tax revenues paid by CEG for CPS. Continued employment of station workers would continue to provide economic benefits to the surrounding communities.

Table 8.0-1 Environmental Impacts Comparison Summary (Sheet 1 of 4)

Impact Area[a]	Proposed Action	Termination of Operations and Decommissioning	No-Action Alternative			
			NGCC Plant	Renewable and Natural Gas Combination	Purchased Power	
					Offsite Generation	Transmission
Land Use	SMALL	SMALL	SMALL	MODERATE	SMALL TO MODERATE	SMALL TO MODERATE
Visual Resources	SMALL	SMALL	SMALL to MODERATE	MODERATE	SMALL to LARGE	SMALL
Air Quality	SMALL	SMALL	SMALL (construction) MODERATE (operations)	SMALL to MODERATE (construction) MODERATE (operations)	SMALL to MODERATE	SMALL
Noise	SMALL	SMALL	SMALL	SMALL to MODERATE (construction) SMALL (operations)	SMALL to MODERATE	SMALL
Geology and Soils	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Surface Water	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Terrestrial	SMALL	SMALL	SMALL	MODERATE	SMALL to LARGE	SMALL
Aquatic	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

Table 8.0-1 Environmental Impacts Comparison Summary (Sheet 2 of 4)

Impact Area[a]	Proposed Action	Termination of Operations and Decommissioning	No-Action Alternative			
			NGCC Plant	Renewable and Natural Gas Combination	Purchased Power	
					Offsite Generation	Transmission
Special Status Species	MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT (rusty patched bumble bee and monarch butterfly); NO EFFECT (other species)	(b)	MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT	MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT	MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT	MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT
Historic and Cultural	NO ADVERSE EFFECT	NO ADVERSE EFFECT	NO EFFECT to ADVERSE EFFECT	NO EFFECT to ADVERSE EFFECT	NO EFFECT to ADVERSE EFFECT	NO EFFECT
Socioeconomics	SMALL	SMALL to MODERATE (termination) SMALL (decommissioning)	SMALL adverse and SMALL beneficial for DeWitt County (operations) SMALL beneficial for DeWitt County (construction)	SMALL adverse and SMALL beneficial for DeWitt County SMALL for all counties	SMALL to LARGE beneficial (existing and new offsite generation) SMALL adverse (existing offsite generation) SMALL to MODERATE adverse (new offsite generation)	No adverse and SMALL beneficial for DeWitt County

Table 8.0-1 Environmental Impacts Comparison Summary (Sheet 3 of 4)

Impact Area[a]	Proposed Action	Termination of Operations and Decommissioning	No-Action Alternative			
			NGCC Plant	Renewable and Natural Gas Combination	Purchased Power	
					Offsite Generation	Transmission
Transportation	SMALL	SMALL	SMALL to MODERATE (construction) SMALL (operations)	SMALL to MODERATE (construction) SMALL (operations)	SMALL SMALL to MODERATE (new offsite generation)	SMALL
Human Health	SMALL	SMALL	SMALL (construction) SMALL to MODERATE (operations)	SMALL (construction) SMALL to MODERATE (operations)	SMALL to MODERATE SMALL (new offsite generation construction)	SMALL

Table 8.0-1 Environmental Impacts Comparison Summary (Sheet 4 of 4)

Impact Area[a]	Proposed Action	Termination of Operations and Decommissioning	No-Action Alternative			
			NGCC Plant	Renewable and Natural Gas Combination	Purchased Power	
					Offsite Generation	Transmission
Environmental Justice	No disproportionately high and adverse effects	[b]	No disproportionately high and adverse effects	No disproportionately high and adverse effects	Site-specific	No disproportionately high and adverse effects
Waste Management	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

a. As defined in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

b. NUREG-0586 Supplement 1 (NRC 2002), the decommissioning GEIS, identifies this resource area as requiring a site-specific analysis based on site conditions at the time of decommissioning, as well as the proposed decommissioning method and activities. Decommissioning CPS would at a minimum occur after the expiration of the current license term. The magnitude of impacts could vary widely based on site-specific conditions at the time and analysis of special status species and/or their habitat(s), a consideration of their presence or their habitats' presence, and an environmental justice analysis of the potential for disproportionately high and adverse impacts from the impacts of decommissioning being experienced by minority or low-income populations as determined by the most recent USCB decennial census data when the alternative is implemented. Thus, CES cannot forecast a level of impact for this resource area without unreasonable speculation.

Table 8.0-2 Alternatives Features Comparison Summary

	NGCC Plant	Renewable and Natural Gas Combination	Purchased Power
Summary of Alternative	Multiple combustion turbines assembled in appropriate power train configurations for a total of 1,241 MWe (gross) (Section 7.2.3.1).	Multiple combustion turbines assembled in appropriate power train configurations for a total of 1,000 MWe (gross); 216 MW of solar installation with battery storage; 652 MWe supplied by wind turbines (Section 7.2.3.2).	Replacement of all energy generation by CPS with purchased power, generated offsite. Construction of additional transmission lines may be necessary dependent upon the location of power generation (Section 7.2.3.3).
Location	CPS site (Section 7.2.3.1.1).	NGCC: CPS Solar: CPS Wind: CPS (Section 7.2.3.2.1).	Offsite.
Cooling System	Closed-cycle cooling (Section 7.2.3.1.6).	NGCC: closed-cycle cooling (Section 7.2.3.2). Solar and Wind: no cooling system required.	No cooling system required.
Land Requirements	54 acres on existing CPS site, 16 miles of natural gas pipeline (Section 7.2.3.1.1).	NGCC: bounded by NGCC alternative. Solar: 1,620 acres total. Wind: construction footprint of 1,610 acres and a permanent footprint of 480 acres. (Section 7.2.3.2.1)	Land use conversion for offsite generation and new transmission, if needed (Section 7.2.3.3.1).
Workforce	Peak construction workforce of 1,200 and construction duration of 2-3 years; operations workforce of 150 (Section 7.2.3.1.9).	NGCC: bounded by that of the NGCC alternative (Section 7.2.3.1.9) Solar and Wind: construction workforce small for a short duration; operational workforce would be a few staff (Section 7.2.3.2.9).	Employment at the facilities supplying the purchased power would be outside of DeWitt County and would not impact the local economy (7.2.3.3.8).

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 1 of 18)

Land Use	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, for the following: • Onsite land use. • Offsite land use.
Termination of Operations and Decommissioning	**SMALL:** Temporary onsite land use changes during decommissioning are anticipated to be comparable to changes that occur during construction and operations and would not require additional land. Temporary changes in onsite land use would not change the fundamental use of the reactor site. (NRC 2013a)
NGCC Plant	**SMALL:** Would be sited at CPS site on approximately 54 acres. The site is zoned General Industrial District. Additional transmission lines would be constructed to connect to existing natural gas transmission lines located offsite. Extension of natural gas pipeline would be approximately 16 miles.
Combination	**MODERATE:** NGCC component bounded by NGCC plant alternative above. Approximately 2,850 acres on site would be used for solar and wind installations. Zoning changes for the portions of the CPS site zoned as Rural Development District would be required.
Purchased Power	**SMALL to MODERATE:** Land use conversion for new generation and transmission of power, if needed, could have a SMALL to MODERATE land use impact, based on the distance of the power source and the amount of reuse of existing transmission infrastructure.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 2 of 18)

Visual Resources	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue finding for aesthetic impacts in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.
Termination of Operations and Decommissioning	**SMALL:** Terminating nuclear power plant operations would not change the visual appearance of the nuclear power plant until demolition of structures. Decommissioning activities would be localized and reduced with implementation of BMPs. (NRC 2013a)
NGCC Plant	**SMALL to MODERATE:** The visual resources impact for the NGCC units and MDCTs would be similar to that of the existing plant.
Combination	**MODERATE:** NGCC component same as for NGCC plant alternative above. Setbacks would seek to minimize visual impacts for the solar and wind installations. The turbines would be visible from all directions and would be lit with obstruction lighting as required.
Purchased Power	**SMALL to LARGE:** When possible, existing utility corridors would be utilized, and the path of newly constructed transmission lines would avoid impacting scenic/PAs. The offsite generation and new construction would have visual impacts dependent upon the type of energy imported, local setback, zoning regulations, and the facility's environs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 3 of 18)

Air Quality	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Air quality impacts (all plants). • Air quality effects of transmission lines.
Termination of Operations and Decommissioning	**SMALL:** After termination of operations, air emissions from the nuclear power plant would continue, but at greatly reduced levels. The most likely impact of decommissioning on air quality is degradation by fugitive dust. Use of BMPs, such as seeding and wetting, can be used to minimize fugitive dust. (NRC 2013a)
NGCC Plant	**SMALL (construction):** Construction impacts would be temporary. Emissions would be maintained within regulatory limits. **MODERATE (operations):** The NGCC plant would be a major source of criteria pollutants and GHGs. Annual emission estimates during the operations period based on EPA emission factors are presented in Table 7.2-1.
Combination	**SMALL to MODERATE (construction):** Construction impacts would be temporary. Fugitive dust would result from clearing approximately 2,850 acres. Emissions would be maintained within regulatory limits. **MODERATE (operations):** The NGCC plant would be a major source of criteria pollutants and GHGs. Annual emission estimates during the operations period based on EPA emission factors are presented in Table 7.2-1. The solar and wind installations would not release any air emissions during operation.
Purchased Power	**SMALL (construction):** Construction related impacts would be construction of new transmission line segments and modification of existing infrastructure. New offsite generation could also be needed. **SMALL to MODERATE (operations of offsite generation):** Air quality impacts from operations would depend on the type of energy imported, local air quality regulations, and the facility's environs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 4 of 18)

Noise	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue finding for noise impacts in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.
Termination of Operations and Decommissioning	**SMALL:** During decommissioning, noise would generally be far enough away from sensitive receptors outside the plant boundaries that the noise would be attenuated to nearly ambient levels and would be scarcely noticeable offsite. Noise abatement procedures could also be used during decommissioning to reduce noise. (NRC 2013a)
NGCC Plant	**SMALL:** Noise impacts from construction activities would be intermittent and last only through the duration of construction; noise impacts during operations would be similar to those currently associated with CPS with the exception of the MDCTs. Sound levels would attenuate and impacts to sensitive receptors is not expected.
Combination	**SMALL to MODERATE (construction):** NGCC component same as for NGCC plant alternative above. Noise impacts from land clearing for solar and the number of turbines that would need to be installed, would range from SMALL to MODERATE dependent on proximity to sensitive receptors. **SMALL (operations):** NGCC component same as for NGCC plant alternative above. During operations, the wind turbines would emit sound that is considered a nuisance but not harmful to human health. No noise impacts would occur from operation of the solar installations.
Purchased Power	**SMALL to MODERATE (offsite generation):** Noise impacts from new construction, if needed, and operations would depend on the type of energy imported, local noise regulations, and the facility's environs. **SMALL:** Construction-related noise impacts associated with the construction of transmission lines are possible depending on the location of the purchased power generation. Sources of noise during construction could include clearing, earthmoving, and installation of equipment/lines.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 5 of 18)

Geology and Soils	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue finding for geology and soils in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.
Termination of Operations and Decommissioning	**SMALL:** Termination of nuclear plant operations is not expected to impact geology and soils. Erosion problems could be mitigated by using BMPs during decommissioning. Site geologic resources would not be affected by decommissioning. (NRC 2013a)
NGCC Plant	**SMALL:** Construction activities would be localized and minimized with implementation of BMPs; land disturbance activities during operations would be conducted in compliance with a stormwater permit and associated BMPs.
Combination	**SMALL:** Construction activities would be localized and minimized with implementation of BMPs; land disturbance activities during operations would be conducted in compliance with a stormwater permit and associated BMPs.
Purchased Power	**SMALL:** Impacts to geology and soils could result from construction activities for transmission or new offsite generation. This would primarily be impacts to soils from clearing and grubbing. These temporary soil impacts would be minimized by implementation of BMPs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 6 of 18)

Surface Water	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Surface water use and quality (non-cooling system impacts) • Altered current patterns at intake and discharge structures • Scouring caused by discharged cooling water • Discharge of metals in cooling system effluent • Discharge of biocides, sanitary waste, and minor chemical spills • Temperature effects on sediment transport capacity
Termination of Operations and Decommissioning	**SMALL:** The NRC concluded that the impacts on water use and water quality from decommissioning would be SMALL for all plants. (NRC 2013a)
NGCC Plant	**SMALL:** Construction impacts would be minimized through adherence to permit requirements and implementation of BMPs. During operations, impacts to surface water would be related to use of Clinton Lake to supply makeup water. Water discharges to Clinton Lake would be regulated under a NPDES permit to protect water quality.
Combination	**SMALL (NGCC):** NGCC component same as for NGCC plant alternative above. **SMALL (solar and wind):** Water needs would be met in compliance with any required water withdrawal permits and applicable regulations. Water quality impacts could result from erosion and runoff associated with the construction of the solar and wind installations. These temporary soil impacts would be minimized by implementation of BMPs and compliance with stormwater permits and applicable regulations. Once in operation, the installations would be operated in compliance with stormwater regulations.
Purchased Power	**SMALL:** Water quality impacts could result from erosion and runoff associated with the construction of transmission lines and new generation facilities, if needed. These temporary soil impacts would be minimized by implementation of BMPs and compliance with stormwater permits and applicable regulations. **SMALL to MODERATE (offsite generation):** Thermoelectric generation would require cooling water. Impacts would depend on the type of energy imported, local noise regulations, and the facility's environs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 7 of 18)

Groundwater	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue finding for groundwater contamination and use (non-cooling system impacts); groundwater use conflicts (plants that withdraw less than 100 gpm); and groundwater quality degradation resulting from water withdrawals in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. **SMALL (radionuclides released to groundwater):** Tritium detected in the groundwater monitoring wells have been well below the drinking water standard.
Termination of Operations and Decommissioning	**SMALL:** Decommissioning activities include some that may affect groundwater quality through the infiltration of water used for various purposes (e.g., cooling of cutting equipment, decontamination spray, and dust suppression). BMPs are expected to be employed as appropriate to collect and manage these waters. Groundwater chemistry may change as rainwater infiltrates through rubble. The increased pH could promote the subsurface transport of radionuclides and metals. However, this effect is expected to occur only over a short distance as a function of the buffering capacity of soil. Offsite transport of groundwater contaminants is not expected. (NRC 2013a)
NGCC Plant	**SMALL:** Compliance with permit conditions, adherence to stormwater regulations, and applying SWPPP mitigation and BMPs would minimize impacts during construction and operation.
Combination	**SMALL:** NGCC component same as for NGCC plant alternative above**.** Water needs for the solar and wind installations would be met in compliance with any required water withdrawal permits and applicable regulations.
Purchased Power	**SMALL:** Construction of supporting transmission lines for the purchased power alternative and new generation facilities, if needed, would require water for dust suppression, equipment washing, and sanitary systems. CEG would utilize the most practical supply and comply with any required water withdrawal permits and applicable regulations. **SMALL to MODERATE (offsite generation):** Thermoelectric generation would require cooling water. Impacts would depend on the type of energy imported, local noise regulations, and the facility's environs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 8 of 18)

Terrestrial	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Exposure of terrestrial organisms to radionuclides • Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds) • Bird collisions with plant structures and transmission lines • Transmission line ROW management impacts on terrestrial resources • Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock) **SMALL (effects on terrestrial resources, non-cooling system impacts)**: Adequate management programs and regulatory controls in place to protect onsite important terrestrial ecosystems.
Termination of Operations and Decommissioning	**SMALL:** The termination of nuclear power plant operations would reduce some impacts and eliminate others. Impacts from systems that continue operating to support other units (i.e., where the license term for each unit does not end at the same time) on the plant site may continue to affect terrestrial biota, but at a reduced level of impact. Areas disturbed or used to support decommissioning are within the operational areas of the site and are also within the PA. Decommissioning activities conducted within the operational areas are not expected to have a detectable impact on important terrestrial resources. (NRC 2013a)
NGCC Plant	**SMALL:** The clearing of vegetation and tree removal for the NGCC plant and pipeline would displace wildlife that occupies the industrial site, and these would disperse to nearby habitats.
Combination	**MODERATE:** The land requirement for siting the generation facilities on the CPS site could impact terrestrial habitats and would remove the CPS site from conservation use. The operation of the wind turbines could affect avian and bat species. Following USFWS guidance would minimize impacts and compliance with any incidental take permits would minimize impacts to special status species.
Purchased Power	**SMALL to LARGE (offsite generation):** The ecological impacts to terrestrial species from construction and operation of needed offsite generation would be SMALL to LARGE primarily depending on the necessary quantity of acreage disturbed and permanent terrestrial habitat removed. **SMALL:** Siting selection would avoid high-quality terrestrial habitat. Construction would include clearing of land and permanent maintenance of vegetation in the ROW.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 9 of 18)

Aquatic	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Impingement and entrainment of aquatic organisms (plants with cooling towers) • Entrainment of phytoplankton and zooplankton (all plants) • Thermal impacts on aquatic organisms (plants with cooling towers) • Infrequently reported thermal impacts (all plants) • Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication • Effects of non-radiological contaminants on aquatic organisms • Exposure of aquatic organisms to radionuclides • Effects on aquatic resources (non-cooling system impacts) • Impacts of transmission line ROW management on aquatic resources • Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses
Termination of Operations and Decommissioning	**SMALL:** The termination of nuclear power plant operations would reduce some impacts and eliminate others. Some aquatic organisms may have become established in the mixing zone because of the warmer environment, and these organisms likely would be adversely affected as the original conditions are restored within the body of water. The NRC concluded that for facilities at which the decommissioning activities would be limited to existing operational areas, the potential impacts on aquatic resources would be SMALL. (NRC 2013a)
NGCC Plant	**SMALL:** Adherence to permits and implementation of BMPs would minimize impacts on aquatic ecosystems during construction. Use of closed-cycle cooling system would minimize impingement and entrainment of aquatic organisms. Compliance with NDPES permit for discharge would minimize impacts to water quality.
Combination	**SMALL:** NGCC plant component of the combination alternative would be similar to those associated with the NGCC plant alternative but requiring about 35 percent less intake and discharge volume. Impacts to aquatic resources from the construction of the solar and wind components of the combination alternative would be minimized by the implementation of BMPs to control erosion and run-off. No operations-related impacts are associated with the solar and wind components of the combination alternative.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 10 of 18)

Aquatic	
Purchased Power	**SMALL to MODERATE (offsite generation):** Construction and industrial activities at offsite generation facilities could impact surface waters, but implementation of stormwater pollution prevention BMPs would minimize impacts. Depending on the type of energy imported, impacts to aquatic resources would result from surface water intake and discharge, and would be SMALL to MODERATE. **SMALL (transmission):** No impacts to aquatic resources would result from the purchased power alternative because of the implementation of BMPs to control erosion and run-off during transmission line construction. No operations-related impacts are associated with the purchased power alternative as power generation would occur offsite.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 11 of 18)

Special Status Species	
Proposed Action	**NO EFFECT to MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT:** No LR-related refurbishment or other LR-related construction activities have been identified. Administrative controls are in place at CPS to ensure that operational changes or construction activities are reviewed, and the impacts minimized through implementation of BMPs. The proposed LR would have no effect on the majority of the protected species. Due to the presence of suitable habitat, the rusty patched bumble bee and monarch butterfly species may be affected, but not likely to be adversely affected by continuing operations.
Termination of Operations and Decommissioning	**Site Specific:** The termination of nuclear power plant operations would reduce some impacts and eliminate others. Impacts from systems that continue operating to support other units (i.e., where the license term for each unit does not end at the same time) on the plant site may continue to affect aquatic biota, but at a reduced level of impact. Some aquatic organisms may have become established in the mixing zone because of the warmer environment, and these organisms likely would be adversely affected as the water temperature cooled and the original conditions were restored within the body of water. The magnitude of impacts could vary widely based on site-specific conditions at the time of decommissioning and the presence or absence of special status species and habitats when the alternative is implemented. (NRC 2013a)
NGCC Plant	**MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT:** The approximately 54 acres at the previously considered ESP site, is available for the NGCC plant. The clearing of vegetation and tree removal for the plant and natural gas pipeline extension would displace wildlife that occupies the industrial site, and these would disperse to nearby habitats.
Combination	**MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT:** The land requirement for locating the NGCC plant, solar and wind installations onsite as well as the pipeline extension could impact terrestrial habitats. The operation of the wind turbines could affect protected avian and bat species. Following USFWS and guidance would minimize impacts and compliance with any incidental take permits would minimize impacts to special status species.
Purchased Power	**MAY AFFECT, NOT LIKELY to ADVERSELY AFFECT:** Construction of new transmission and new generation facilities, if needed, would require clearing of terrestrial habitat that could be suitable for federally and state listed species. Construction of transmission lines may be necessary dependent upon the location of the purchased power generation.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 12 of 18)

Historic and Cultural Resources	
Proposed Action	**NO ADVERSE EFFECT:** No LR-related refurbishment or construction activities identified; administrative controls ensure protection of cultural resources in the event of excavation activities.
Termination of Operations and Decommissioning	**NO ADVERSE EFFECT:** The termination of nuclear plant operations would not affect historic or cultural resources. The NRC conducted an analysis of the potential effects of decommissioning on historic and archaeological (cultural) resources and found that the potential onsite impacts at sites where the disturbance of lands would not go beyond the operational areas would be SMALL. (NRC 2013a)
NGCC Plant	**NO EFFECT to ADVERSE EFFECT:** Siting the NGCC at the CPS site could require land that has not been surveyed for cultural resources and the vicinity is described as archaeologically sensitive. Pipeline extension construction could also impact cultural sites. Illinois stormwater regulations require a review of recorded cultural sites. No federal permit would be required for upland construction activities for the NGCC.
Combination	**NO EFFECT to ADVERSE EFFECT:** Illinois stormwater regulations require a review of recorded cultural sites. No federal permit would be required for upland construction activities for the new generating installations and pipeline extension. Most of the CPS site has not been investigated for cultural resources. Archaeological and other cultural resources could be affected.
Purchased Power	**NO EFFECT to ADVERSE EFFECT (offsite generation):** If new construction is required, cultural resources could be impacted depending on local and state cultural reviews and protections. **NO EFFECT (transmission):** Development of transmission lines could impact cultural resources, depending on the siting location, however consideration would be taken to utilize existing transmission lines and construct new lines in areas that do not contain historic and cultural resources.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 13 of 18)

Socioeconomics	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Employment and income, recreation, and tourism • Tax revenues • Community services and education • Population and housing • Transportation
Termination of Operations and Decommissioning	**SMALL to MODERATE (termination):** There would be immediate socioeconomic impacts from the loss of jobs. The impacts from the loss or reduction of tax revenue due to the termination of station operations on community and public education services could range from SMALL to LARGE (NRC 2013a). The tax payments attributable to CPS provide a LARGE beneficial economic impact to DeWitt County. Loss of the operational and temporary (outage) personnel would affect various aspects of the local community including employment, taxes, housing, off-site land use, economic structure, and public services. **SMALL (decommissioning):** Decommissioning itself has no impact on the tax base and no detectable impact on the demand for public services. The impacts of decommissioning on socioeconomics are neither detectable nor destabilizing; therefore, the impacts on socioeconomics are SMALL. (NRC 2002)
NGCC Plant	**SMALL:** The construction and operations employment would provide a stimulus to the local economy (**beneficial** impact) as well as include demands in community services (**adverse** impact). The size of the construction workforce and duration of construction would temporarily stimulate the local economy. Economic impact of construction and operations employment and tax payments would be SMALL in DeWitt County. **SMALL to MODERATE (construction traffic); SMALL (operations traffic):** Construction commuting would increase traffic and congestion on the local roadways. Transportation impacts would decrease after construction.
Combination	**SMALL:** NGCC component bounded by the NGCC plant alternative above. The jobs created to complete the construction of solar and wind installations would add to the small adverse and beneficial impact in DeWitt County. **SMALL to MODERATE (construction traffic); SMALL (operations traffic):** Construction at the CPS site would increase traffic on the local roads temporarily. The workers at the NGCC plant and the few required for maintenance and operation of solar and wind installations would be less than construction.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 14 of 18)

Socioeconomics	
Purchased Power	**SMALL to LARGE (offsite generation):** The impact to the economy where the generation facilities are located would be SMALL to LARGE beneficial impacts depending on the size of the local economy. If new construction is required, the adverse impacts would likely be SMALL to MODERATE depending on the existing community infrastructure. **SMALL (transmission):** Any construction jobs created due to transmission line construction would be temporary in nature. Employment at the facilities supplying the purchased power would be outside of DeWitt County and would not impact the local economy. **SMALL to MODERATE (offsite generation construction traffic); SMALL (offsite generation operations traffic):** Traffic impacts at offsite generation sites would be dependent on the local road infrastructure and size of construction workforce. Operations workforces would likely be accommodated with existing infrastructure. **SMALL (transmission):** The size of the construction workforce and amount of equipment transported to the transmission line locations would be temporary and minimal.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 15 of 18)

Human Health	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Radiation exposures to the public • Radiation exposures to plant workers • Human health impact from chemicals • Microbiological hazards to plant workers • Physical occupational hazards **SMALL (microbiological hazards to the public):** CPS's thermal discharge offshore, submerged discharge to Clinton Lake would not enhance the concentration of thermophilic organisms. The thermal plume temperatures would be well below the optimum growth temperature for thermophilic organisms of particular concern. **SMALL (electric shock hazards):** In-scope transmission lines are located entirely within CPS's owner-controlled area and comply with current NESC clearance standards. CES also has procedures in place to review and control proposed structural changes to maintain compliance with the NESC clearance standards. Procedures govern the use of equipment near transmission lines to maintain adequate distance to prevent electrical shock.
Termination of Operations and Decommissioning	**SMALL:** The human health impacts from physical, chemical, and microbiological hazards during the termination of plant operations and decommissioning would be SMALL for all plants (NRC 2013a).
NGCC Plant	**SMALL (construction); SMALL to MODERATE (operations):** Compliance with OSHA worker protection rules would control impacts on workers at acceptable levels during construction and operation. The radiological human health impact on workers due to working in proximity to CPS would be SMALL due to compliance with NRC regulations and adherence to ALARA principles. The NGCC plant would emit criteria air pollutants that can create health problems. Technology would be installed to limit the criteria air pollutant releases.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 16 of 18)

Human Health	
Combination	**SMALL (construction); MODERATE (operations):** Compliance with OSHA worker protection rules would control impacts on workers from construction activities. Wind turbines sound is considered a nuisance rather than harmful to human health. The radiological human health impact on workers due to working in proximity to CPS would be SMALL due to compliance with NRC regulations and adherence to ALARA principles. The NGCC plant would emit criteria air pollutants that can create health problems. Technology would be installed to limit the criteria air pollutant releases.
Purchased Power	**SMALL (construction, offsite generation, and transmission); SMALL to MODERATE (offsite generation operations):** During construction of transmission lines and new generation, if needed, worker safety would be addressed by following the OSHA worker protection standards. Impacts from operation would be dependent upon the type of energy imported, local regulations and the facility's environs.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 17 of 18)

Environmental Justice	
Proposed Action	**No disproportionately high and adverse impacts to minority and low-income populations:** The closest minority population is adjacent to the western side of the CPS site, and the closest low-income population is approximately 19 miles south-southwest of the site center point. (Section 3.11.2). Based on known pathways, there are no expected disproportionately high and adverse impacts on minority or low-income populations from the proposed action (Section 4.10.1.4.2).
Termination of Operations and Decommissioning	Termination of power plant operations and the resulting loss of jobs, income, and tax revenue could have a disproportionate effect on minority and low-income populations (NRC 2013a). **Site Specific:** The determination of whether the minority or low-income populations are disproportionately highly and adversely impacted by facility decommissioning activities needs to be made on a site-by-site basis because their presence and their socioeconomic circumstances would be site specific (NRC 2002).
NGCC Plant	**No disproportionately high and adverse impacts to minority and low-income populations:** Minority and low-income populations are more than 18 miles from the developed portion of the CPS site. Minor environmental impacts such as fugitive dust and noise and socioeconomic impacts from construction would be temporary and short in duration. Because air emissions are expected to remain within regulatory standards, impacts from emissions are not expected to be high and adverse.
Combination	**No disproportionately high and adverse impacts to minority and low-income populations:** Minority and low-income populations are several miles from the CPS site. Minor environmental impacts such as fugitive dust and noise and socioeconomic impacts from construction would be temporary and short in duration. Because air emissions from the NGCC plant are expected to remain within regulatory standards, impacts from emissions are not expected to be high and adverse.
Purchased Power	**Site-specific (offsite generation):** Impacts from new construction and operations of new and existing generation facilities would be dependent upon the type of the power generation facility, construction activities, and the proximity of minority and low-income populations. **No disproportionately high and adverse impacts to minority and low-income populations (transmission):** Impacts during construction of transmission lines would be temporary and likely would result in no disproportionately high and adverse impacts to minority and low-income populations. Minor environmental impacts such as fugitive dust and noise and socioeconomic impacts from traffic could occur. These impacts would be temporary and short in duration. No disproportionately high and adverse effects would be expected for minority or low-income communities.

Table 8.0-3 Environmental Impacts Comparison Detail (Sheet 18 of 18)

Waste Management	
Proposed Action	**SMALL:** Adopting by reference the Category 1 issue findings in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 for the following: • Low-level waste storage and disposal • Onsite storage of SNF • Offsite radiological impacts of SNF and high-level waste disposal • Mixed waste storage and disposal • Nonradioactive waste storage and disposal.
Termination of Operations and Decommissioning	**SMALL:** After termination of nuclear plant operations, there would be a period before the beginning of decommissioning when the reactor would be placed in a cold shutdown condition and maintained. The quantities of waste generated would be smaller than the quantities generated during either operations or decommissioning. The impacts associated with the management of LLRW, hazardous waste, mixed waste, and nonradioactive and nonhazardous waste during operations and decommissioning would be SMALL. (NRC 2013a)
NGCC Plant	**SMALL:** Construction-related waste would be properly characterized and disposed of at permitted offsite facilities; spent selective catalytic reduction catalysts would make up the majority of the waste during operations; operations-related waste would be managed and recycled or disposed of at permitted offsite facilities.
Combination	**SMALL:** Construction-related waste would be properly characterized and disposed of at permitted offsite facilities; during operations, nonhazardous and hazardous wastes would be managed in compliance with federal and state regulations and disposed of in permitted facilities.
Purchased Power	**SMALL (offsite generation and transmission):** Construction-related waste would be properly characterized and disposed of at permitted offsite facilities. Waste from operations would be handled at the power generation facility which would be located off-site.

9.0 STATUS OF COMPLIANCE

The environmental report shall list all federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by federal, state, regional, and local agencies having responsibility for environmental protection. [10 CFR 51.45(d)]

9.1 CPS Authorizations

Table 9.1-1 provides a summary of authorizations held by CPS for current station operations. Authorizations in this context include any permits, licenses, approvals, or other entitlements that would continue to be in place, as appropriate, throughout the PEO given their respective renewal schedules. Table 9.1-2 lists additional environmental authorizations and consultations related to license renewal of the CPS Unit 1.

9.2 Status of Compliance

CPS has established control measures in place to ensure compliance with the authorizations listed in Table 9.1-1, including monitoring, reporting, and operating within specified limits. CPS environmental compliance staff are primarily responsible for monitoring and ensuring that the site complies with its environmental permits and applicable regulations. Monitoring and sampling results associated with environmental programs are submitted to appropriate agencies as specified in the permits and/or governing regulations.

9.3 Notices of Violations

Based on a review of records for the period 2018–2022 of various environmental programs and permits that CPS is subject to and complies with, there have been two NOVs issued to the facility by either federal, state, or local regulatory agencies. Due to a failed circuit breaker, continuous turbidity data were not collected for the station drinking water system June 17–18, 2021. The circuit breaker was replaced and IDPH was notified of the equipment failure and corrective actions. CEG considers this issue closed. In addition, a quarterly sample for coliform was not collected for the period ending June 30, 2020, from the Personnel Beach Recreation Area groundwater well for the period beginning April 1, 2020. Compliance was achieved by subsequent sampling and the IDPH Drinking Water Branch closed the issue August 31, 2020. CEG also considers this issue closed.

Table 9.1-1 Environmental Authorizations for Current CPS Operations (Sheet 1 of 3)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
NRC	AEA [10 CFR Part 50]	CPS license to operate Unit 1	NPF-62	4/17/2027	Operation of CPS Unit 1.
EPA/IEPA	CWA Section 401 [33 USC 1341]	Certification of water quality standards	N/A	N/A	Discharge into waters of the United States, permitted under the Illinois NPDES permit.
USDOT	49 USC 5180 [49 CFR Part 107, Subpart G]	Registration	051022550113EG	6/30/2025	Hazardous material shipments.
Tennessee Department of Environment and Conservation (TDEC)	TDEC Rule 0400-20-10-.32	License to ship radioactive material	T-IL004-L23	12/31/2023	Shipment of radioactive material to a licensed disposal/processing facility in Tennessee.
Utah Department of Environmental Quality (UDEQ)	Utah Administrative Code R313-26	General Site Access Permit for Radioactive Waste Disposal	0110000033	7/28/2024	Delivery of radioactive waste to a land disposal facility located in Utah.

Table 9.1-1 Environmental Authorizations for Current CPS Operations (Sheet 2 of 3)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
IEPA	RCRA [42USC 6912] and IEPA Title 35 Ill. Adm. Code, Parts 700-739	Hazardous Waste Generator License	ILD000806075	4/30/2024	Authorizes facility to operate as a hazardous waste generator.
IEPA	IEPA Title 35 Ill. Adm. Code, Subtitle C and/or D, Chapter 1, and the CWA	NPDES Permit	IL0036919	3/31/2025	Discharges of stormwater, wastewater and treated water to waters of the state.
IEPA	IEPA, Title 35 Ill. Adm. Code, Subtitle C, Chapter 1, and the CWA	General NPDES Permit	1LG870019	9/30/2027	Pesticide Application Point Source Discharges.
IEPA	IEPA Title 35 Ill. Adm. Code, Subtitle B, Chapter 1, and the CAA	Air Emission Permit	039804AAC	4/18/2024	Operate air emission sources (4 diesel generators, diesel fire pump, 3 flexible pumps, and heating boiler).
IEPA	IEPA Title 35 Part 380	Certification	311999999	7/1/2028	Class K (Industrial) Wastewater Treatment Works Operator.
IDPH and SDWA	IDPH, Title 77 Ill. Adm. Code, Chapter 1, Subchapter r, Part 900, and Safe Drinking Water Act	Registration	Water System No. IL3111153 (Clinton Power Station Personnel Beach Rec Area Well)	N/A	Transient, non-community water system.

Table 9.1-1 Environmental Authorizations for Current CPS Operations (Sheet 3 of 3)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
IDPH and SDWA	IDPH, Title 77 Ill. Adm. Code, Chapter 1, Part 900 Drinking Water System Code, and Part 930 Surface Source Water Treatment Code, Ill. Pollution Control Board 35 Ill. Adm. Code Part 611 Primary Drinking Water Standards and Safe Drinking Water Act	Permit	Water System No. IL3112201	N/A	Non-transient, non-community public water system No. IL3112201
IDPH	IDPH, Title 77 Ill Adm. Code, Chapter 1, Subchapter r, Part 900.45	Certification	Operator ID: 24661	12/31/2026	Operate Non-Transient, Non-Community Public Water System
IDPH	IDPH, Title 77 Ill. Adm. Code 820	License	134-08208	5/1/2024	Beach Facility License
IDOT/Division of Water Resources Permit IDOT	Ch 19, par. 5.2 IDNR IDOT/Division of Water Resources	Operating & Maintenance Permit	18199	N/A	Operating and Maintenance Permit for Clinton Lake Dam

Table 9.1-2 Environmental Authorizations and Consultations for CPS License Renewal (Sheet 1 of 2)

Agency	Authority	Requirement	Remarks
NRC	AEA [42 USC 2011 *et seq*.]	License Renewal	Applicant for federal license must submit an ER in support of an LRA.
USFWS	ESA, Section 7 [16 USC 1536]	Consultation	Requires federal agency issuing a license to consult with the USFWS, regarding federally protected species.
EPA/IEPA	CWA, Section 401 [33 USC 1341]	Certification	Requires state certification that the proposed action would comply with CWA Standards.
IDNR, Office of Realty and Environmental Planning	ESA, Section 7 [16 USC 1536]	Consultation	Applicant may consult with state agency to support a timely and thorough review of potential impacts to threatened and endangered species and important habitats.
IDPH	10 CFR 51, Subpart A; Regulatory Guide 4.2, Revision 1, Supplement 1, Section 3.9	Consultation	Applicant should consult the State agency responsible for environmental health regarding the potential existence and concentration of microorganisms in the receiving waters for station cooling water discharge.
Illinois State Historic Preservation Office (ISHPO)	NHPA, Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with ISHPO and/or tribal historic preservation officer (THPO).
Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas	NHPA, Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with THPO.
Kickapoo Tribe of Oklahoma	NHPA, Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with THPO.

Table 9.1-2 Environmental Authorizations and Consultations for CPS License Renewal (Sheet 2 of 2)

Agency	Authority	Requirement	Remarks
Menominee Indian Tribe of Wisconsin	NHPA, Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with THPO.
Miami Tribe of Oklahoma	NHPA, Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with THPO.

9.4 Remediation Activities

Based on reviews of records for the period 2018–2022, there are no ongoing or completed nonradiological or radiological remediation activities at CPS. In addition, there were no reportable spills applicable to federal, state, or local regulations at CPS during this 5-year period. CEG implements an RGPP (Section 3.6.2.4) to evaluate the potential for radionuclide contamination at or near the generating station.

As discussed in Section 3.6.4.2, a tritium release occurred adjacent to the former cycled condensate storage tank in May 2006. The area is monitored under the RGPP. Tritium was detected in wells near the former cycled condensate storage tank in 2018 through 2022 during at least one sampling event each year, with the highest concentration of 1,500 pCi/L during this 5-year period. However, concentrations are well below the EPA drinking water limit of 20,000 pCi/L, and there does not appear to be an active source of tritium to groundwater at CPS.

9.5 Federal, State, and Local Regulatory Standards: Discussion of Compliance

This section contains information regarding various environmental programs identified in the 2013 GEIS that may or may not be applicable to the site, and current status of compliance with each program.

9.5.1 Atomic Energy Act

The AEA gives the NRC responsibility for licensing and regulating commercial uses of nuclear energy and allows the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the Act through regulations set forth in Title 10 of the CFR.

9.5.1.1 Radioactive Waste

As discussed in Section 2.2.6, CEG has radioactive waste stream handling and shipping procedures. As a generator of both LLRW and spent fuel, CPS is subject to and complies with provisions and requirements of the Low-Level Radioactive Waste Policy Amendment Act of 1985 and the Nuclear Waste Policy Act of 1982, as subsequently amended. Radioactive solid waste generation and disposal/treatment shipments are reported in CPS's annual radioactive effluent release reports as required.

9.5.2 Clean Air Act

Emissions from nonradiological air pollution sources, including the criteria pollutants, are controlled through compliance with federal, state, and local regulations. The CAA and air quality is discussed in Section 3.3.3. There are no Class I Federal areas, in which visibility is an important value, as designated in 40 CFR, Part 81, Subpart D, within 100 miles of CPS.

9.5.2.1 Air Permit

CPS operates its air emission sources in compliance with IEPA 35 Illinois Administrative Code, Subtitle B (Chapter 1). As presented in Section 3.3.3.2, CPS holds a FESOP. Air Emission Permit No. 039804AAC provides for operation of three large diesel-powered generating units, one 755-horsepower diesel-powered generator, four smaller diesel-powered generators, three diesel-powered fire pumps, three storage tanks, two oil separator units and three parts washers.

9.5.2.2 Chemical Accident Prevention Provisions [40 CFR 68]

The quantity of regulated chemicals at CPS does not exceed the threshold quantities specified in 40 CFR 68.130 and therefore is not subject to risk management plan requirements under 40 CFR 68.

9.5.2.3 Stratospheric Ozone [40 CFR Part 82]

Under Title VI of the CAA, the EPA is responsible for several programs that protect the stratospheric ozone layer. Regulations promulgated by the EPA to protect the ozone layer are contained in 40 CFR 82. A number of service practices, refrigerant reclamation, technician certification, and other requirements are covered by these programs. CPS is in compliance with the requirements established in Sections 608 of the CAA and 40 CFR, Part 82, Subpart F and Subpart H and the implementing requirements codified in these regulations. The program to manage stationary refrigeration appliances at CPS is described in CEG's procedure applicable to employees, and contractors for the management of ozone depleting substances in compliance with federal regulations.

9.5.3 Clean Water Act

9.5.3.1 Water Quality (401) Certification

Federal CWA Section 401 requires applicants for a federal license to conduct an activity that might result in a discharge into navigable waters provide the licensing agency with a certification from the state that the discharge will comply with applicable CWA requirements [33 USC 1341]. IEPA issued a 401 certification to CPS on August 11, 1975. The certification is included with NPDES Permit No. IL0036919 issued by the EPA. (NRC 1982) CEG reached out to IEPA to confirm that this certification remains valid for the license renewal term. The IEPA issued a waiver of the CWA Section 401 Water Quality Certification on February 3, 2023, regarding CPS's license renewal. This correspondence is located in Attachment E.

9.5.3.2 NPDES Permit

CPS's NPDES permit (Permit No. IL0036919) is included in Attachment B to the ER. It authorizes the discharges from 11 outfalls (two internal and nine external). Discharges include process wastewaters, stormwater runoff, and wastewater from CPS's water treatment facility. The nine external outfalls discharge to Clinton Lake. The external outfalls are depicted in Figure 3.6-3 and effluent limits for the 11 outfalls are listed in Table 3.6-2 (Section 3.6.1.2.1).

CPS did not receive any NOVs for wastewaters discharges to receiving surface waters over the 5-year period of 2018 through 2022.

9.5.3.3 Industrial Stormwater Discharge

Stormwater discharges associated with CPS industrial activities are regulated and controlled through NPDES Permit No. IL0036919 issued by the IEPA. Outfalls that include stormwater discharges are 004, 005 and 011. A further discussion of stormwater management is presented in Section 3.6.1.2.2. CEG also maintains and implements a SWPPP that identifies potential sources of pollution, including erosion, which would reasonably be expected to affect the quality of stormwater. It also identifies BMPs that would be used to prevent or reduce the pollutants in stormwater discharges. CPS is in compliance with the terms and conditions of the NPDES permit as it relates to stormwater.

CPS is also subject to IEPA's General NPDES Permit for pesticide application point-source discharges (Permit No. ILG87-0019, expiration date September 30, 2027) and operates in compliance with this permit. A timely permit renewal application was submitted to IEPA on March 16, 2021, prior to the permit's expiration date. CEG's experience is that the IEPA does not typically provide application acceptance confirmation. However, the permit is administratively extended, in accordance with 35 IAC 309.104(a)(2), which states:

> *The terms and conditions of an expiring permit remain effective and enforceable against the discharger until the Agency takes final action on the pending permit application, only if:*
>
> *A. The permittee has submitted a timely application pursuant to subsection (a)(1); and*
>
> *B. The Agency, through no fault of the permittee, does not issue a new permit on or before the expiration date of the previous permit.*

9.5.3.4 Sanitary Wastewaters

As discussed in Section 3.6.1.2.3, CPS treats sanitary wastewater in its own STP. The STP serves as the collection, storage, and processing facility for CPS's sanitary wastewater. The system was designed to meet the discharge requirements of the NPDES permit. Sewage treatment consists of primary and secondary aerated lagoon cells. The primary aeration lagoon has four aerator motors that provide oxygen for bacteria. Sanitary effluent is normally treated by tertiary sand filtration before release to the circulating water discharge flume.

9.5.3.5 Spill Prevention, Control, and Countermeasures

The EPA's Oil Pollution Prevention Rule became effective January 10, 1974, and was published under the authority of Section 311(j)(1)(C) of the federal Water Pollution Control Act. The regulation has been published in 40 CFR Part 112, and facilities subject to the rule must prepare and implement an SPCC plan to prevent any discharge of oil into or upon navigable waters of the United States or adjoining shorelines. CPS is subject to this rule and has a written SPCC plan that identifies and describes the procedures, materials, equipment, and facilities that are utilized at the station to minimize the frequency and severity of oil spills to meet the requirements of this rule.

9.5.3.6 Reportable Spills [40 CFR Part 110]

CPS is subject to the reporting provisions of 40 CFR Part 110 as it relates to the discharge of oil in such quantities as may be harmful pursuant to Section 311(b)(4) of the federal Water Pollution Control Act. Any discharges of oil in such quantities that may be harmful to public health, welfare, or the environment must be reported to the National Response Center. Based on a review of site records 2018–2022, there have been no releases at CPS that have triggered this notification requirement.

9.5.3.7 Facility Response Plan

CPS is not subject to the facility response plan risk requirements described in 40 CFR 112.20 because the facility does not transfer oil over water to or from vessels and does not store oil in quantities greater than one million gallons.

9.5.3.8 Section 404 Permit

CPS does not have any Section 404 permits in place because they do not perform routine dredging. Since 1978, dredging was performed once at the UHS in 1991, and dredging would likely be required during the LR term. However, CEG would obtain any necessary permits prior to conducting dredging or other activities that would require a Section 404 permit.

9.5.4 Safe Drinking Water Act

CPS withdraws potable water from Clinton Lake and treats it in an onsite system, Water System No. L3111153. This system is regulated as a non-community non-transient public water system. In addition, CPS has a drinking water supply well at the Personnel Beach Recreation Area, Water System No. L3111153, which is regulated as a non-community transient public water system.

As the operator of these water systems, CPS is subject to the federal SDWA. State governments, such as Illinois', are approved to implement these rules and drinking water standards for the EPA through waterworks regulations. Illinois established regulations for drinking water standards, 35 IAC Part 611, operation, and maintenance requirements for non-community public water systems under 77 IAC Part 900 and Part 930 surface source water treatment. CPS has a certified water systems operator on staff who is responsible for maintaining compliance with SDWA regulations; therefore, the site is in compliance with federal and state drinking water regulations.

9.5.5 Endangered Species Act

Section 7 of the ESA requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of species that are listed, or proposed for listing, as endangered, or threatened. Depending on the action involved, the ESA requires consultation with the USFWS, and with the National Marine Fisheries Service if marine or anadromous species could be affected. As discussed in Section 3.7.8.1, federally listed threatened or endangered species possibly occurring within a 6-mile radius of CPS include the Indiana bat, northern long-eared bat, Eastern Massasauga rattlesnake, rusty patched bumble bee, and eastern prairie fringed orchid. Additionally, the monarch butterfly is a federal candidate species. CPS has plans and procedures in place to comply with the requirements of the ESA and, therefore, is in compliance with this act.

9.5.6 Migratory Bird Treaty Act

The MBTA makes it unlawful to pursue, hunt, take, capture, kill, or sell protected migratory bird species, and grants protection to any bird parts, including feathers, eggs, and nests. In addition to species protected under federal and state endangered species acts, there are numerous bird species protected under the MBTA that may visit CPS. CPS adheres to the MBTA and does not currently hold any MBTA-related permits (Section 3.7.8.4).

9.5.7 Bald and Golden Eagle Protection Act

The BGEPA prohibits the take, transport, sale, barter, trade, import and export, and possession of eagles, making it illegal for anyone to collect eagles and eagle parts, nests, or eggs without a USFWS permit. As discussed in Section 3.7.8.3, bald eagles have been observed in the vicinity of the CPS site; however, no eagles or eagle nests have been observed at the CPS operating station itself. There are currently no BGEPA permitting requirements associated with CPS operations.

9.5.8 Magnuson-Stevens Fishery Conservation and Management Act

As stated in Section 3.7.8.5, EFH is defined under the Magnuson-Stevens Fishery Conservation and Management Act and refers to waters and substrate necessary for fish to spawn, breed, feed or grow to maturity. No EFH is located within the vicinity of CPS, nor were any EFH areas protected from fishing. As HAPCs are derived from EFH, there were also no HAPCs located within the 6-mile vicinity of CPS.

9.5.9 Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits, with certain exceptions, the “take” of marine mammals in United States waters and by United States citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. There are currently no Marine Mammal Protection Act permitting requirements associated with CPS operations.

9.5.10 Coastal Zone Management Act

The Federal Coastal Zone Management Act (16 USC 1451 et seq.) imposes requirements on an applicant for a federal license to conduct an activity that could affect a state's coastal zone. The Act requires the applicant to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program ([16 USC 1456(c)(3)(A)]). Illinois has an approved Coastal Management Program (CMP). An LR is a new federal action which triggers the requirement for a certification if the facility is located within the area covered by a CMP. CPS is located in DeWitt County, which is not within Illinois' CMP area. (ICMP 2011)

9.5.11 Wild and Scenic Rivers Act

Section 7(a) of the Wild and Scenic Rivers Act requires federal agencies to determine whether the operation of the project under a new license would invade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the designated river corridor. Illinois has one river, the Vermilion River, approximately 70 miles east of CPS that has a stretch of 17.1 miles designated as wild and scenic. However, there are no waterbodies at or adjacent to CPS designated as a wild and scenic river. (NWSRS 1989)

9.5.12 National Historic Preservation Act

Section 106 of the NHPA [54 USC 306108] requires federal agencies having the authority to license any undertaking, prior to issuing the license, to consider the effect of the undertaking on historic properties and to afford the Advisory Council on Historic Preservation an opportunity to comment on the undertaking. Council regulations provide for establishing an agreement with any SHPO to substitute state review for council review [35 CFR 800.7]. Although not required of an applicant by federal law or NRC regulation, to provide early consultation for the Section 106 process, CEG contacted the IDNR Historic Preservation Division for informal consultation concerning the CPS LRA. Native American groups recognized as potential stakeholders were also consulted by CEG with the opportunity for comment. CEG correspondence is included in Attachment D.

Furthermore, as discussed in Section 3.8.6, CPS has administrative procedures to protect previously unknown historic or cultural resources that may be discovered on the site.

9.5.13 Resource Conservation and Recovery Act

9.5.13.1 Nonradioactive Waste

As a generator of hazardous and nonhazardous wastes, CPS is subject to and complies with the RCRA and specific IEPA regulations contained in IEPA Title 35 Illinois Administrative Code, Parts 700-739. CPS is classified as a small quantity generator of hazardous waste. As a generator of hazardous waste, CPS also maintains a hazardous waste generator identification number (Table 9.1-1). For most hazardous waste records, the regulations require that records be retained for at least 3 years from the date the hazardous waste is last shipped offsite.

Records are maintained in accordance with the CEG's waste management procedures and established record keeping requirements. An IEPA RCRA inspection and walkdown was conducted at CPS on November 16, 2021, and no issues were noted.

9.5.13.2 Reportable Spills [40 CFR 262]

CPS is subject to the reporting provisions of 40 CFR 262.34(d)(5)(iv)(C) as it relates to a fire, explosion, or other release of hazardous waste, which could threaten human health outside the facility boundary or when the facility has knowledge that a spill has reached surface water. Any such events must be reported to the National Response Center. Based on review of site records 2018–2022, no reportable spills of hazardous waste have occurred.

9.5.13.3 Mixed Waste

Radioactive materials are regulated by the NRC under the AEA of 1954, and hazardous waste is regulated by the EPA under the RCRA of 1976. CPS rarely generates mixed waste, and the last shipment of mixed waste was in 2020. CEG has a conditional exemption from IEPA for low-level mixed waste in accordance with 40 CFR 266, Subpart N, in place for any mixed waste placed in storage at CPS storage units listed under the exemption. If generated, mixed waste would be managed onsite in accordance with NRC regulations and the conditional exemption requirements.

9.5.13.4 Underground Storage Tanks [40 CFR 280 and 41 IAC]

CPS does not have buried or partially buried storage tanks, as regulated under 40 CFR 280 and 41 IAC.

9.5.13.5 Aboveground Storage Tanks [41 IAC 160 & 180]

Aboveground storage tanks (ASTs) used for diesel fuel or other petroleum products are regulated under CWA regulations referred to as SPCC rule (40 CFR 112). In Illinois, ASTs that store gasoline and other petroleum products are also under the oversight of the Office of the State Fire Marshall and are subject to inspection (41 IAC 160 & 180). Currently, in Illinois, there is no requirement for registration of ASTs. A review of site records 2018–2022 indicates there were no releases requiring reporting under this regulation.

To comply with 40 CFR 112, CPS's SPCC plan lists the onsite facilities and petroleum storage vessels and inspection requirements. The CPS SPCC plan conforms with applicable requirements.

The State of Illinois owns, and is responsible for, a diesel AST located at the Illinois Department of Nuclear Safety building on the CPS site.

In the diesel generator building, the facility has three below-grade vaulted diesel storage tanks that supply the emergency diesel generators. Since the facility is a nuclear power generation station licensed by the NRC and subject to NRC provisions regarding design and quality criteria, including, but not limited to, 10 CFR Part 50, these three below-grade tanks are exempt from SPCC requirements under 40 CFR 112.1(4).

9.5.14 Pollution Prevention Act

In accordance with RCRA Section 3002(b) and 40 CFR 262.27, a small or large quantity generator must certify that there is a waste minimization program in place to reduce the volume and toxicity of the waste generated to the degree determined to be economically practical. CPS is meeting this requirement, as procedural measures are in place to minimize hazardous waste generated to the maximum extent practical.

9.5.15 Federal Insecticide, Fungicide and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. Ch 6 subpart 136 requires that pesticides distributed or sold in the United States must be registered (licensed) by the EPA. Commercially approved herbicides are applied by a licensed contractor on an as-needed basis to control vegetation. CEG has procedures in place to comply with regulatory requirements (federal FIFRA, state 8 IAC 250). CPS also operates under IEPA's General NPDES Permit for pesticide application point source discharges. CEG uses licensed applicators for restricted use pesticides. Therefore, CPS complies with the requirements of these acts.

9.5.16 Toxic Substances Control Act

The Toxic Substances Control Act of 1976 regulates polychlorinated biphenyls (PCBs) [40 CFR Part 761] and asbestos [40 CFR Part 763], both of which may be present at CPS. CEG has procedures in place for the management, removal, and disposal of PCBs and asbestos to ensure compliance with PCB federal [40 CFR Part 761] and state [35 IAC 721.108] regulations and asbestos federal [CFR Part 763] and state [77 IAC 855 Subpart A through D] regulations.

9.5.17 Hazardous Materials Transportation Act

Because CPS ships hazardous materials regulated by the DOT offsite, it is subject to and complies with the applicable requirements of the Hazardous Materials Transportation Act described in Title 49 of the CFR, including the requirement to possess a current hazardous materials certificate of registration (Table 9.1-1). In addition, CPS maintains and complies with the permits issued by the TDEC and UDEQ for shipping radioactive material to a licensed disposal/processing facility within the states of Tennessee and Utah (Table 9.1-1).

9.5.18 Emergency Planning and Community Right-to-Know Act

CPS is subject to and complies with Section 312 of the Emergency Planning and Community Right-to-Know Act that requires annual submittal of an emergency and hazardous chemical inventory report (Tier II) to the local emergency planning commission, the state emergency response committee, and the local fire department. This report typically includes, but is not limited to, diesel fuel, hydroxyethylidenediphosphonic acid (water treatment chemical), hydrotreated light naphthenic distillate (petroleum), lead/lead dioxide, nitrogen, phosphoric acid, sodium benzotriazole, sodium bisulfite, sodium hydroxide, sodium hypochlorite, sodium polyphosphates, sulfuric acid, and zinc chloride. State requirements related to this Act are contained in 29 IAC 620.

9.5.19 Comprehensive Environmental Response, Compensation, and Liability Act

CPS is subject to the hazardous substance release and reporting provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as subsequently amended. State requirements related to this Act are contained in 29 IAC 620. Any release of reportable quantities of listed hazardous substances to the environment requires a notification to the EPA's National Response Center, Illinois Emergency Management Agency, and the Local Emergency Planning Committee as appropriate with a written follow-up. Based on a review of records over the 5-year period 2018–2022, there have been no releases at CPS that have triggered this notification requirement.

9.5.20 Farmland Protection Policy Act

The Farmland Policy Protection Act applies only to federal programs. The term "federal program" under this act does not include federal permitting or licensing for activities on private or non-federal lands. Therefore, because license renewal is considered a federal licensing activity and CPS is located on non-federal land, this act is not applicable.

9.5.21 Federal Aviation Act

Coordination with the FAA is required to ensure that the highest structures associated with a project do not impair aviation safety. Submission of a letter of notification (with accompanying maps and project description) to the FAA would result in a written response from the FAA certifying that no hazard exits or recommending project changes and/or the installation of warning devices such as lighting.

As discussed in Section 3.2.3, predominant visual features at CPS include the meteorological tower, containment dome and associated turbine building. The containment building dome is the most visible feature at the site with a height of approximately 196 feet. No LR-related construction activities have been identified; therefore, no new FAA notification is required.

9.5.22 Occupational Safety and Health Act

OSHA governs the occupational safety and health of the construction workers and operations staff. As discussed in Section 3.10, CPS and its contractors comply with OSHA's requirements which are incorporated in the station's occupational health and safety practices.

9.5.23 State Water Use Program

As discussed in Section 3.6.3.1, CPS's water is sourced from Clinton Lake, Water System No. IL3112201, and the State of Illinois does not require a surface water withdrawal permit for CPS. As described in Section 3.6.3.2, CPS does not use groundwater as a potable resource for station operations.

Although not used for station operations, two potable wells are located on CPS property and both wells are permitted with IDPH. Well API 120392153600 is located in the Personnel Beach Recreation Area, and CPS is not required to measure groundwater withdrawals in this well. The other well on the southern portion of the CPS site is the water supply well for the Village of DeWitt. Additional details are provided in Section 3.6.3.2.

CEG also has Beach Facility License No. 134-08208 for the Personnel Beach Recreation Area and complies with the requirements of Title 77 IAC 820.

9.5.24 National Program for Inspection of Non-Federal Dams [33 CFR 222.6]

As discussed in Section 3.6.1, CPS's water source is Clinton Lake which was created by the construction of an earthen dam. IDOT Permit No. 18199, authorized February 20, 1985, allows for operation and maintenance of the dam. The National Dam Inspection Act, August 8, 1972, authorizes the Secretary of the Army, acting through the Chief of Engineers, to carry out a national program of inspection of non-federal dams for the purpose of protecting human life and property. In addition, Illinois has regulations under 17 IAC 3702 for Construction and maintenance of dams and CPS has procedures in place to maintain the functional and structural integrity of the dam and complies with these requirements.

9.5.25 DeWitt County Zoning Requirements

DeWitt County zoning is discussed in Section 3.2.1. CPS is in compliance with the county's zoning requirements in that station operations are located in an area zoned industrial and no LR-related development is planned.

9.6 Environmental Reviews

CPS has procedural controls in place to ensure all environmentally sensitive areas at CPS, if present, are adequately protected during site operation and project planning. These controls, which encompass non-radiological environmental resource areas, such as land use, air quality, surface water and groundwater, terrestrial and aquatic ecology, historic and cultural resources, waste management, and pollution prevention, consist of the following:

- Appropriate local, state, and/or federal permits are obtained or modified, as necessary.
- BMPs, including for stormwater, are implemented to protect wetlands and sensitive ecosystems.
- Appropriate agencies are consulted on matters involving federally and state-listed threatened, endangered, and protected species; BMPs are implemented to minimize impacts to these species.
- Appropriate agencies are consulted on matters involving cultural resources and to ensure BMPs are implemented to minimize impacts to this resource.

In summary, CEG's administrative controls ensure that appropriate local, state, and/or federal permits are obtained or modified as necessary, that cultural resources and threatened and endangered species are protected if present, and that other regulatory issues are adequately addressed, as necessary.

9.7 Alternatives

The discussion of alternatives in the report shall include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements. [10 CFR 51.45(d)]

No-action alternatives are discussed in Chapter 7. In the event that the NRC does not issue a subsequent renewed license for CPS and one of the no-action alternatives were implemented, the alternate generating facilities could be constructed and operated to comply with applicable environmental quality standards and regulations.

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10.1.1 Figure References

No.	Title	Complete Reference Citations
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3.1-2	CPS Area Topography	COO 2022; USCB 2020a; USDA 2022a
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3.8-1	Historical Illinois Topography Map 1855	ILDC 2022
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3.11-1 through 3.11-12	EJ Figures Minority Populations	USCB 2020a; USCB 2020b
3.11-13 through 3.11-16	EJ Figures Low-Income Populations	USCB 2020a; USCB 2020b

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Attachment A: NEPA Issues

NRC NEPA Issues for License Renewal of Nuclear Power Plants

Clinton Power Station Environmental Report

NRC NEPA Issues for License Renewal of Nuclear Power Plants

Constellation Energy Generation, LLC (CEG) has prepared this environmental report in accordance with the requirements of U.S. Nuclear Regulatory Commission (NRC) regulation 10 CFR 51.53. The NRC included in the regulation the list of 78 National Environmental Policy Act (NEPA) issues for license renewal of nuclear power plants that were identified in the 2013 GEIS (Appendix B to Subpart A of 10 CFR Part 51, Table B-1).

The following table lists the 78 issues from 10 CFR Part 51, Appendix B, Table B-1, and identifies the section in this environmental report in which CEG addresses each issue.

Table A-1. Clinton Power Station Environmental Report Cross-Reference of License Renewal NEPA Issues

No.	Issue[a]	Category	ER Section	GEIS Cross Reference (Section/Page)[b]
	Land Use			
1	Onsite land use	1	4.1	4.2.1.1/4-6
2	Offsite land use	1	4.1	4.2.1.1/4-7
3	Offsite land use in transmission line rights-of-way	1	4.0.1	4.2.1.1/4-6
	Visual Resources			
4	Aesthetic impacts	1	4.1	4.2.1.2/4-9
	Air Quality			
5	Air quality (all plants)	1	4.2	4.3.1.1/4-14
6	Air quality effects of transmission lines	1	4.2	4.3.1.1/4-14
	Noise			
7	Noise impacts	1	4.3	4.3.1.2/4-19
	Geologic Impacts			
8	Geology and soils	1	4.4	4.4/4-29
	Surface Water Resources			
9	Surface water use and quality (non-cooling system impacts)	1	4.5	4.5.1.1/4-30
10	Altered current patterns at intake and discharge structures	1	4.5	4.5.1.1/4-36
11	Altered salinity gradients	1	4.0.1	4.5.1.1/4-36
12	Altered thermal stratification of lakes	1	4.5	4.5.1.1/4-37
13	Scouring caused by discharged cooling water	1	4.5	4.5.1.1/4-38
14	Discharge of metals in cooling system effluent	1	4.5	4.5.1.1/4-38
15	Discharge of biocides, sanitary wastes, and minor chemical spills	1	4.5	4.5.1.1/4-39
16	Surface water use conflicts (plants with once-through cooling systems)	1	4.5	4.5.1.1/4-40
17	Surface water use conflicts (plants with cooling ponds, or cooling towers using makeup water from a river)	2	4.5.1	4.5.1.1/4-41
18	Effects of dredging on surface water quality	1	4.5	4.5.1.1/4-42
19	Temperature effects on sediment transport capacity	1	4.5	4.5.1.1/4-43

No.	Issue[a]	Category	ER Section	GEIS Cross Reference (Section/Page)[b]
	Groundwater Resources			
20	Groundwater contamination and use (non-cooling system impacts)	1	4.5	4.5.1.2/4-45
21	Groundwater use conflicts (plants that withdraw <100 gpm)	1	4.5	4.5.1.2/4-47
22	Groundwater use conflicts (plants that withdraw >100 gpm)	2	4.5.3	4.5.1.2/4-48
23	Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river)	2	4.5.2	4.5.1.2/4-48
24	Groundwater quality degradation resulting from water withdrawals	1	4.0.1	4.5.1.2/4-49
25	Groundwater quality degradation (plants with cooling ponds in salt marshes)	1	4.0.1	4.5.1.2/4-50
26	Groundwater quality degradation (plants with cooling ponds at inland sites)	2	4.5.4	4.5.1.2/4-51
27	Radionuclides released to groundwater	2	4.5.5	4.5.1.2/4-51
	Terrestrial Resources			
28	Effects on terrestrial resources (non-cooling system impacts)	2	4.6.5	4.6.1.1/4-59
29	Exposure of terrestrial organism to radionuclides	1	4.6	4.6.1.1/4-61
30	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)	1	4.6	4.6.1.1/4-64
31	Cooling tower impacts on vegetation (plants with cooling towers)	1	4.6	4.6.1.1/4-69
32	Bird collisions with plant structures and transmission lines	1	4.6	4.6.1.1/4-70
33	Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	2	4.6.4	4.6.1.1/4-75
34	Transmission line ROW management impacts on terrestrial resources	1	4.6	4.6.1.1/4-75
35	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	1	4.6	4.6.1.1/4-80
	Aquatic Resources			
36	Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	2	4.6.1	4.6.1.2/4-87

No.	Issue[a]	Category	ER Section	GEIS Cross Reference (Section/Page)[b]
37	Impingement and entrainment of aquatic organisms (plants with cooling towers)	1	4.0.1	4.6.1.2/4-92
38	Entrainment of phytoplankton and zooplankton (all plants)	1	4.6	4.6.1.2/4-93
39	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	2	4.6.2	4.6.1.2/4-94
40	Thermal impacts on aquatic organisms (plants with cooling towers)	1	4.0.1	4.6.1.2/4-96
41	Infrequently reported thermal impacts (all plants)	1	4.6	4.6.1.2/4-97
42	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication	1	4.6	4.6.1.2/4-100
43	Effects of non-radiological contaminants on aquatic organisms	1	4.6	4.6.1.2/4-103
44	Exposure of aquatic organisms to radionuclides	1	4.6	4.6.1.2/4-105
45	Effect of dredging on aquatic organisms	1	4.6	4.6.1.2/4-107
46	Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	2	4.6.3	4.6.1.2/4-109
47	Effects on aquatic resources (non-cooling system impacts)	1	4.6	4.6.1.2/4-110
48	Impacts of transmission line ROW management on aquatic resources	1	4.6	4.6.1.2/4-112
49	Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses	1	4.6	4.6.1.2/4-110
	Special Status Species and Habitats			
50	Threatened, endangered, and protected species and essential fish habitat	2	4.6.6	4.6.1.3/4-115
	Historic and Cultural Resources			
51	Historic and cultural resources	2	4.7	4.7.1/4-122
	Socioeconomics			
52	Employment and income, recreation and tourism	1	4.8	4.8.1.1/4-127
53	Tax revenues	1	4.8	4.8.1.1/4-128
54	Community services and education	1	4.8	4.8.1.1/4-129
55	Population and housing	1	4.8	4.8.1.1/4-130
56	Transportation	1	4.8	4.8.1.1/4-131
	Human Health			
57	Radiation exposures to the public	1	4.9	4.9.1.1.1/4-140

No.	Issue[a]	Category	ER Section	GEIS Cross Reference (Section/Page)[b]
58	Radiation exposures to plant workers	1	4.9	4.9.1.1.1/4-136
59	Human health impacts from chemicals	1	4.9	4.9.1.1.2/4-147
60	Microbiological hazards to the public (plants that use cooling ponds, lake, or canals or that discharge to a river)	2	4.9.1	4.9.1.1.3/4-149
61	Microbiological hazards to plant workers	1	4.9	4.9.1.1.3/4-149
62	Chronic effects of electromagnetic fields	UC	4.0.3	4.9.1.1.4/4-150
63	Physical occupational hazards	1	4.9	4.9.1.1.5/4-156
64	Electric shock hazards	2	4.9.2	4.9.1.1.5/4-156
	Postulated Accidents			
65	Design-basis accidents	1	4.9	4.9.1.2/4-158
66	Severe accidents	2	4.15	4.9.1.2/4-158
	Environmental Justice			
67	Minority and low-income populations	2	4.10	4.10.1/4-167
	Waste Management			
68	Low-level waste storage and disposal	1	4.11	4.11.1.1/4-171
69	Onsite storage of spent nuclear fuel	1	4.11	4.11.1.2/4-172
70	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal	1	4.11	4.11.1.3/4-175
71	Mixed waste storage and disposal	1	4.11	4.11.1.4/4-178
72	Non-radioactive waste storage and disposal	1	4.11	4.11.1.5/4-179
	Cumulative Impacts			
73	Cumulative impacts	2	4.12	4.13/4-243
	Uranium Fuel Cycle			
74	Offsite radiological impacts–individual impacts from other than the disposal of spent fuel and high-level waste	1	4.13	4.12.1.1/4-193
75	Offsite radiological impacts–collective impacts from other than the disposal of spent fuel and high-level waste	1	4.13	4.12.1.1/4-194
76	Non-radiological Impacts of the uranium fuel cycle	1	4.13	4.12.1.1/4-194
77	Transportation	1	4.13	4.12.1.1/4-196
	Termination of Nuclear Power Plant Operations and Decommissioning			
78	Termination of plant operations and decommissioning	1	4.14	4.12.2.1/4-201

a. 10 CFR 51, Subpart A, Appendix A, Table B-1 (issue numbers added to facilitate discussion).

b. Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437, Rev 1).

UC = uncategorized (categorization and impact finding definitions do not apply to the issue).

Attachment B: NPDES Permit

Exelon Generation.

U-604632
May 12, 2021

Via Electronic Mail and Certified Mail

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Clinton Power Station, Unit 1
Facility Operating License No. NPF-62
NRC Docket No. 50-461

Subject: Clinton Power Station National Pollutant Discharge Elimination System (NPDES) Permit No, IL0036919

In accordance with the 30-day notification requirement of Appendix B, "Environmental Protection Plan", Section 3.2, "Reporting Related to the NPDES Permits and State Certification", to the Clinton Power Station Facility Operation License, Exelon Generation Company, LLC is providing a copy of the reissued National Pollutant Discharge Elimination System (NPDES) Permit for Clinton Power Station, Unit 1. The subject permit was reissued to Exelon on March 31, 2020, became effective on April 1, 2020, and modified on May 3rd, 2021,

There are no regulatory commitments contained in this document.

Should you have any questions concerning this document, please contact Mr. Dale Shelton, Regulatory Assurance Manager, at (217) 937-2800.

Respectfully,

Norha Z. Plumey
Plant Manager
Clinton Power Station

Attachment

cc:

NRC Regional Administrator – Region III
NRC Senior Resident Inspector – Clinton Power Station

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397

JB PRITZKER, GOVERNOR **JOHN J. KIM**, DIRECTOR

217/782-0610

May 3, 2021

Exelon Generation Company, LLC
8401 Power Road
Clinton, Illinois 61727

Re: Exelon Generation Company, LLC – Clinton Power Station
NPDES Permit No. IL0036919
Bureau ID# W0398040001
Final Modified Permit

Gentlemen:

Attached is the final Modified NPDES Permit for your discharge. The Permit as issued covers discharge limitations, monitoring, and reporting requirements. Failure to meet any portion of the Permit could result in civil and/or criminal penalties. The Illinois Environmental Protection Agency is ready and willing to assist you in interpreting any of the conditions of the Permit as they relate specifically to your discharge. The following changes were made since the public notice of the permit:

1. The reference to Special Condition 23 has been removed for zinc at outfall 007.

2. Visual or remote inspections and annual certification of the cooling water intake structure has been added to Special Condition 10 in order to achieve requirements pursuant to 40 CFR 125.96(e) and 40 CFR 125.97(c), respectively.

Pursuant to the Final NPDES Electronic Reporting Rule, all permittees must report DMRs electronically unless a waiver has been granted by the Agency. The Agency utilizes NetDMR, a web based application, which allows the submittal of electronic Discharge Monitoring Reports instead of paper Discharge Monitoring Reports (DMRs). More information regarding NetDMR can be found on the Agency website, https://www2.illinois.gov/epa/topics/water-quality/surface-water/netdmr/Pages/quick-answer-guide.aspx. If your facility has received a waiver from the NetDMR program, a supply of preprinted paper DMR Forms will be sent to your facility during the interim period prior to your registration in the NetDMR program. Additional information and instructions will accompany the preprinted DMRs. Please see the attachment regarding the electronic reporting rule.

The attached Modified Permit is effective as of the date indicated on the first page of the Permit. Until the effective date of any re-issued Permit, the limitations and conditions of the previously-issued Permit remain in full effect. You have the right to appeal any condition of the Permit to the Illinois Pollution Control Board within a 35 day period following the issuance date.

Should you have questions concerning the Permit, please contact Mark E. Liska at 217/782-0610.

Sincerely,

Darin LeCrone, P.E.
Manager, Industrial Unit, Permit Section
Division of Water Pollution Control

DEL:SBS:21021601.docx

Attachment: Final Modified Permit

cc: Records Unit
Compliance Assurance Section
Champaign Region
Billing

NPDES Permit No. IL0036919

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Modified (NPDES) Permit

Expiration Date: March 31, 2025

Issue Date: March 31, 2020
Effective Date: April 1, 2020
Modification Date: May 3, 2021

Name and Address of Permittee:

Exelon Generation Company, LLC
8401 Power Road
Clinton, Illinois 61727

Facility Name and Address:

Exelon Generation Company, LLC
Clinton Power Station
8401 Power Road
Clinton, Illinois 61727
(DeWitt County)

Discharge Number and Name:	Receiving Waters:
002 Discharge Flume	Clinton Lake
A02 Sewage Treatment Plant Effluent	
B02 Radwaste Treatment System Effluent	
003 Water Treatment Waste	Clinton Lake
004 Transformer Area Oil/Water Separator	Clinton Lake
005 Diesel Generator Oil/Water Separator	Clinton Lake
006 Screen House Intake Screen Backwash	Clinton Lake
007 Safe Shutdown Service Water System	Clinton Lake
008 Unheated Pump Bearing Cooling Waters	Clinton Lake
011 Sedimentation Pond Runoff	Clinton Lake
015 Ultimate Heat Sink Dredge Pond Discharge	Clinton Lake

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Darin LeCrone, P.E.
Manager, Permit Section
Division of Water Pollution Control

DEL:SBS:21021601.docx

 Modification Date: May 3, 2021

NPDES Permit No. IL0036919

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 002 – Discharge Flume
(Average Flow = 965 MGD)

This discharge consists of:

1. Main Condenser Cooling Water
2. Station Service Water*
3. Makeup Water Treatment System
4. Screenhouse Sump Discharges
5. Sewage Treatment Plant Effluent (A02)
6. Radwaste Treatment System Effluent (B02)

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				Daily	Estimate
pH	See Special Condition 2.				1/Month	Grab
Total Residual Chlorine	See Special Conditions 3 and 6.			0.05	1/Month	Grab
Temperature	See Special Condition 4 and 22.				Daily	Continuous
Zinc (Total)	See Special Condition 23.		Monitor Only		1/Quarter	Grab
Phosphorus (Total)	See Special Condition 24.		Monitor Only		1/Quarter	Grab

* - Station Service Water discharge consists of various pump and bearing cooling waters, various heat exchangers, chillers, and HVAC system and fire protection system maintenance flush waters.

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall A02 – Sewage Treatment Plant Effluent
(DAF = 0.088 MGD)

This discharge consists of:

1. Sewage Treatment Plant Effluent
2. Process Simulator Refrigeration Unit
3. Ventilation & Service Air Compressor Condensate
4. Equipment Maintenance Wastewater
5. Fire Protection & Service Water
6. Laboratory Chemicals*

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				Daily	Measure
BOD_5	22	75	30	60	1/Month	24-Hour Composite
Total Suspended Solids	22	75	30	60	1/Month	24-Hour Composite
Fecal Coliform**	See Special Condition 16.		Monitor Only		1/Month	Grab

* - See Special Condition 11.
** - During the months of May – October.

Outfall B02 – Radwaste Treatment System Effluent
(Average Flow = 0.072 MGD)

This discharge consists of:

1. Equipment Drain Subsystem
2. Floor Drain Subsystem
3. Laundry Waste Subsystem
4. Chemical Waste Subsystem
5. Laboratory Chemicals*
6. Equipment Maintenance Wastewater

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				Daily	Measure
Total Suspended Solids			15	30	1/Month	Grab**
Oil & Grease			15	20	1/Month	Grab**

* - See Special Condition 11.
** - See Special Condition 12.

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 003 – Water Treatment Wastes
(Average Flow = 0.288 MGD)

This discharge consists of:

1. Upflow Filter backwash
2. Reverse Osmosis Unit Reject Waste
3. Mixed Bed Polishers Off - Specification Water
4. Sand Filter Backwash
5. Auxillary Boiler Blowdown
6. Standby Liquid Control Pump
7. Surveillance Operation Wastewater
8. Equipment Maintenance Wastewater
9. Laboratory Chemicals
10. Reverse Osmosis Unit Cleaning Chemicals
11. Ventilation and Service Air Compressor Condensate

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				Daily	Measure
pH	See Special Condition 2.				1/Month	Grab
Total Suspended Solids			15	30	1/Month	Grab
Oil & Grease			15	20	1/Month	Grab

Outfall 004 – Transformer Area Oil/Water Separator
(Intermittent Discharge)

This discharge consists of:

1. Machine Shop Area Floor Drains
2. Paint Storage Room Floor Drains
3. Oil Tank Area & Turbine Oil Transfer Pump Area Drains
4. Transformer Area Drains
5. Diesel Generator Area Drains
6. Equipment Maintenance Wastewater
7. Stormwater Runoff
8. Ventilation and Service Air Compressor Condensate

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				1/Month	Estimate
pH	See Special Condition 2.				1/Month	Grab
Oil & Grease			15	20	1/Month	Grab
Total Suspended Solids			15	30	1/Month	Grab

NPDES Permit No. IL0036919

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 005 – Diesel Generator Area Oil/Water Separator
(Intermittent Discharge)

This discharge consists of:

1. Diesel Generator Building Floor Drains
2. Diesel Fuel Storage Area Drains
3. Fuel Unloading Area Drains
4. Equipment Maintenance Wastewaters
5. Transformer Area Drains
6. Stormwater Runoff

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				1/Month	Estimate
pH	See Special Condition 2.				1/Month	Grab
Total Suspended Solids			15	30	1/Month	Grab
Oil & Grease			15	20	1/Month	Grab

Outfall 006 – Screenhouse Intake Discharges
(Average Flow = 0.072 MGD)

This discharge consists of:

1. Screenhouse Intake Screen Backwash*
2. Warming Line Waters
3. Service Water Backflow
4. Non-Chlorinated Sample Water

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				1/Month	Estimate

* - There shall be no intentional discharge of collected debris. See Special Condition 5.

NPDES Permit No. IL0036919

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 007 – Safe Shutdown Service Water System (Average Flow = 35 MGD)						

This discharge consists of:

1. Equipment Cooling Water
2. Diesel Generator Cooling Water
3. Residual Heat Removal Heat Exchangers

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				Daily	Measure
pH	See Special Condition 2.				1/Month	Grab
Total Residual Chlorine	See Special Condition 6.			0.05	1/Month	Grab
Zinc (Total)	See Special Condition 23 and 26.		Monitor Only		1/Month	Grab
Phosphorus (Total)	See Special Condition 24.		Monitor Only		1/Quarter	Grab

Outfall 008 – Unheated Pump Bearing Cooling Waters*
(Intermittent Discharge)

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1.				1/Day When Discharging	Estimate

* - This discharge occurs only during refueling and other forced outages.

NPDES Permit No. IL0036919

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharges shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 011 – Sedimentation Pond Runoff* (Intermittent Discharge)						
* - See Special Condition 14.						
Outfall 015 – Ultimate Heat Sink Dredge Pond Discharge (Intermittent Discharge)						
Flow (MGD)	See Special Condition 1.				1/Day When Discharging	Estimate
pH	See Special Condition 2.				1/Day When Discharging	Grab
Total Suspended Solids			15	30	1/Day When Discharging	Grab

Special Conditions

SPECIAL CONDITION 1. Flow shall be measured in units of Million Gallons per Day and reported as a monthly average and a daily maximum on the discharge monitoring report.

SPECIAL CONDITION 2. The pH shall be in the range of 6.0 to 9.0. The minimum and maximum values shall be reported on the DMR form.

SPECIAL CONDITION 3. Continuous monitoring throughout a representative chlorination period shall be performed once per month above the second drop structure in the discharge flume during the respective chlorination period allowing for lag time between the initiation of chlorination and the point of sampling. If continuous monitoring cannot be performed, a single grab sample (1/month) shall be taken in the discharge flume during a discharge representative of a chlorination period. The result of the grab sample shall be reported including the time of collection, the time and duration of the chlorine dosing period plus the amount (lbs/day) of chlorine applied. For continuous chlorine monitoring, analytical data from only one representative 24-hr monitoring period each month need be reported on the monthly discharge monitoring report. For continuous monitoring, the chlorine concentration curve, the time of sampling, the time and duration of the chlorine dosing period plus the amount (lbs/day) of chlorine applied shall be reported.

If only service water is discharged to the discharge flume during a normal monthly monitoring period, a single grab sample (1/month) may be taken for determining compliance with TRC limitations. The single grab sample must be taken during a representative chlorination period, with the duration of chlorination reported in the quarterly reports.

SPECIAL CONDITION 4. Exelon Generation, LLC's demonstration for the Clinton Generating Station in accordance with Section 316(a) of the CWA was approved by the Illinois Pollution Control Board in Order 92-142, dated August 26, 1993, which resulted in the following thermal limitation and is hereby being renewed in accordance with 35 Ill. Adm. Code 106.1180.

The temperature of the discharge to Clinton Lake from Clinton Power Station, as measured at the second drop structure of the discharge flume, shall be limited to a daily average temperature which (1) does not exceed 99 degrees Fahrenheit during more than 90 days in a fixed calendar year running from January 1, through December 31, and (2) does not exceed 110.7 degrees Fahrenheit for any given day.

Compliance with the water temperature monitoring requirements shall be determined by reporting the daily average and daily maximum water temperature of the discharge. The number of days the daily average temperature exceeds 99.0° F during the calendar year shall also be reported.

For up to 15-days per calendar year Clinton Power Station may measure compliance with the thermal limits of this Special Condition 4 by subtracting 8.5°F from the condenser water outlet temperature if two circulating pumps are in operation or by subtracting 6.3°F if three circulating pumps are in operation. All calculated second drop temperatures must be identified. The permittee shall report to the Agency those times when continuous monitoring was not performed, the reason it was not performed, and the amount of days.

SPECIAL CONDITION 5. The intake structures shall be operated and maintained so as to minimize the possible adverse impact on water quality which might result from the discharge of any collected debris or fish. So as to minimize possible adverse impacts, for purposes of this permit, intake structure operation and maintenance shall include, but not be limited to, the following: Outer bar racks and intake screens shall be routinely cleaned and collected debris properly disposed.

SPECIAL CONDITION 6. All samples for Total Residual Chlorine shall be analyzed by an applicable method contained in 40 CFR 136, equivalent in accuracy to low-level amperometric titration. Any analytical variability of the method used shall be considered when determining the accuracy and precision of the results obtained.

For the purposes of this permit, TRC means those substances which include combined and uncombined forms of both chlorine and bromine and which are expressed, by convention, as an equivalent concentration of molecular chlorine.

SPECIAL CONDITION 7. There shall be no discharge of polychlorinated biphenyl compounds (PCBs).

SPECIAL CONDITION 8. In accordance with IPCB Order PCB 92-142, Clinton Power Station is required to conduct a continuous Temperature Monitoring Program at site 1.5 that will be located at a submerged depth of 0.5 meters in Salt Creek approximately 100 feet down the stream from the bottom of the spillway of Clinton Lake during the months of June, July, and August of each year, during the life of this permit. Results shall be submitted to the Agency by the following January.

SPECIAL CONDITION 9. If the permittee intends to request the continuation of the 316(a) alternative thermal limits in its next reissued NPDES permit, the permittee shall submit the information necessary to comply with 35 Ill. Adm. Code 106.1180 as part of the application for renewal of this permit. The permittee must reevaluate the study area using methods similar to those used in pre-variance fish surveys to demonstrate that the discharge has not caused appreciable harm to the balanced, indigenous population of shellfish, fish, and wildlife in Clinton Lake.

Special Conditions

SPECIAL CONDITION 10. Exelon Generation Company, LLC submitted, in accordance with Section 316(b) of the Clean Water Act, the required information under 40 CFR 122.21(r)(1)(ii). The Agency has determined that the operation of the cooling lake, which constitutes closed-cycle cooling, meets the Best Technology Available (BTA) for impingement mortality, as defined under 40 CFR 125.94(c)(1). Based on available information at the time of permit reissuance, the Agency has determined that the operation of the cooling water intake structure meets the equivalent of Best Technology Available (BTA) for entrainment in accordance with the Best Professional Judgment provisions of 40 CFR 125.90(b) and 125.98(b)(5). In order for the Agency to make a BTA determination for entrainment the facility must complete an entrainment characterization study as approved by the Agency. Exelon shall submit an entrainment study plan to the Agency within 90 days of the effective date of this permit. The entrainment study plan shall require that the results of the entrainment characterization study be submitted to the Agency within 36 months of the date of approval of the entrainment study plan.

Nothing in this permit authorizes take for the purposes of a facility's compliance with the Endangered Species Act.

A. The permittee shall conduct visual inspections and/or employ remote monitoring devices during times when the cooling water intake structure is in operation on a weekly basis to ensure that all technologies operated to comply with 40 CFR 125.94 are maintained and operated to function as designed. These weekly monitoring inspections shall be noted on the monthly NetDMR form. The weekly visual inspection documentation shall be made available to the Agency and general public upon written request.

B. The permittee shall submit an annual certification statement signed by the responsible corporate office as defined in 40 CFR 122.22 subject to the following:

   1. If the information contained in the previous year's annual certification is still pertinent, you may simply state as such in a letter and the letter, along with any applicable data submission requirements specified in this section shall constitute the annual certification.

   2. If you have substantially modified operation of any unit at your facility that impacts cooling water withdrawals or operation of your cooling water intake structures, you must provide a summary of those changes in the report. In addition, you must submit revisions to the information required pursuant to 40 CFR122.21(r) in your next permit application.

SPECIAL CONDITION 11. Unused laboratory chemicals shall be discharged at a rate and in a manner so as not to upset normal operation or cause pass through at the sewage treatment plant, or the Radwaste Treatment System.

SPECIAL CONDITION 12. A grab sample shall be taken during the discharge of each Radwaste Treatment System effluent holding tank. A grab sample shall be taken each time a tank is discharged.

SPECIAL CONDITION 13. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) electronic forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee is required to submit electronic DMRs (NetDMRs) instead of mailing paper DMRs to the IEPA unless a waiver has been granted by the Agency. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, http://www.epa.state.il.us/water/net-dmr/index.html.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 28th day of the following month, unless otherwise specified by the permitting authority.

Permittees that have been granted a waiver shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attention: Compliance Assurance Section, Mail Code # 19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 14.

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

Special Conditions

A. A storm water pollution prevention plan shall be maintained by the permittee for the storm water associated with industrial activity at this facility. The plan shall identify potential sources of pollution which may be expected to affect the quality of storm water discharges associated with the industrial activity at the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce the pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit. The permittee shall modify the plan if substantive changes are made or occur affecting compliance with this condition.

1. Waters not classified as impaired pursuant to Section 303(d) of the Clean Water Act.

   Unless otherwise specified by federal regulation, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event.

2. Waters classified as impaired pursuant to Section 303(d) of the Clean Water Act

   For any site which discharges directly to an impaired water identified in the Agency's 303(d) listing, and if any parameter in the subject discharge has been identified as the cause of impairment, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event. If required by federal regulations, the storm water pollution prevention plan shall adhere to a more restrictive design criteria.

B. The operator or owner of the facility shall make a copy of the plan available to the Agency at any reasonable time upon request.

Facilities which discharge to a municipal separate storm sewer system shall also make a copy available to the operator of the municipal system at any reasonable time upon request.

C. The permittee may be notified by the Agency at any time that the plan does not meet the requirements of this condition. After such notification, the permittee shall make changes to the plan and shall submit a written certification that the requested changes have been made. Unless otherwise provided, the permittee shall have 30 days after such notification to make the changes.

D. The discharger shall amend the plan whenever there is a change in construction, operation, or maintenance which may affect the discharge of significant quantities of pollutants to the waters of the State or if a quarterly visual observation required by paragraph H or the annual facility inspection required by paragraph I of this condition indicates that an amendment is needed. The plan should also be amended if the discharger is in violation of any conditions of this permit, or has not achieved the general objective of controlling pollutants in storm water discharges. Amendments to the plan shall be made within 30 days of any proposed construction or operational changes at the facility, and shall be provided to the Agency for review upon request.

E. The plan shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from storm water outfalls at the facility. The plan shall include, at a minimum, the following items:

1. A topographic map extending one-quarter mile beyond the property boundaries of the facility, showing: the facility, surface water bodies, wells (including injection wells), seepage pits, infiltration ponds, and the discharge points where the facility's storm water discharges to a municipal storm drain system or other water body. The requirements of this paragraph may be included on the site map if appropriate. Any map or portion of map may be withheld for security reasons.

2. A site map showing:

   i. The storm water conveyance and discharge structures;

   ii. An outline of the storm water drainage areas for each storm water discharge point;

   iii. Paved areas and buildings;

   iv. Areas used for outdoor manufacturing, storage, or disposal of significant materials, including activities that generate significant quantities of dust or particulates.

   v. Location of existing storm water structural control measures (dikes, coverings, detention facilities, etc.);

   vi. Surface water locations and/or municipal storm drain locations

   vii. Areas of existing and potential soil erosion;

   viii. Vehicle service areas;

Special Conditions

ix. Material loading, unloading, and access areas.

x. Areas under items iv and ix above may be withheld from the site for security reasons.

3. A narrative description of the following:

   i. The nature of the industrial activities conducted at the site, including a description of significant materials that are treated, stored or disposed of in a manner to allow exposure to storm water;

   ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharges;

   iii. Existing structural and non-structural control measures to reduce pollutants in storm water discharges;

   iv. Industrial storm water discharge treatment facilities;

   v. Methods of onsite storage and disposal of significant materials.

4. A list of the types of pollutants that have a reasonable potential to be present in storm water discharges in significant quantities. Also provide a list of any pollutant that is listed as impaired in the most recent 303(d) report.

5. An estimate of the size of the facility in acres or square feet, and the percent of the facility that has impervious areas such as pavement or buildings.

6. A summary of existing sampling data describing pollutants in storm water discharges.

F. The plan shall describe the storm water management controls which will be implemented by the facility. The appropriate controls shall reflect identified existing and potential sources of pollutants at the facility. The description of the storm water management controls shall include:

1. Storm Water Pollution Prevention Personnel - Identification by job titles of the individuals who are responsible for developing, implementing, and revising the plan.

2. Preventive Maintenance - Procedures for inspection and maintenance of storm water conveyance system devices such as oil/water separators, catch basins, etc., and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

3. Good Housekeeping - Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

4. Spill Prevention and Response - Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, spill cleanup equipment and procedures should be identified, as appropriate. Internal notification procedures for spills of significant materials should be established.

5. Storm Water Management Practices - Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants, measures to remove pollutants from storm water discharge shall be implemented. In developing the plan, the following management practices shall be considered:

   i. Containment - Storage within berms or other secondary containment devices to prevent leaks and spills from entering storm water runoff. To the maximum extent practicable storm water discharged from any area where material handling equipment or activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water should not enter vegetated areas or surface waters or infiltrate into the soil unless adequate treatment is provided.

   ii. Oil & Grease Separation - Oil/water separators, booms, skimmers or other methods to minimize oil contaminated storm water discharges.

   iii. Debris & Sediment Control - Screens, booms, sediment ponds or other methods to reduce debris and sediment in storm water discharges.

Special Conditions

iv. Waste Chemical Disposal - Waste chemicals such as antifreeze, degreasers and used oils shall be recycled or disposed of in an approved manner and in a way which prevents them from entering storm water discharges.

v. Storm Water Diversion - Storm water diversion away from materials manufacturing, storage and other areas of potential storm water contamination. Minimize the quantity of storm water entering areas where material handling equipment of activities, raw material, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water using green infrastructure techniques where practicable in the areas outside the exposure area, and otherwise divert storm water away from exposure area.

vi. Covered Storage or Manufacturing Areas - Covered fueling operations, materials manufacturing and storage areas to prevent contact with storm water.

vii. Storm Water Reduction - Install vegetation on roofs of buildings within adjacent to the exposure area to detain and evapotranspirate runoff where precipitation falling on the roof is not exposed to contaminants, to minimize storm water runoff; capture storm water in devices that minimize the amount of storm water runoff and use this water as appropriate based on quality.

6. Sediment and Erosion Prevention - The plan shall identify areas which due to topography, activities, or other factors, have a high potential for significant soil erosion. The plan shall describe measures to limit erosion.

7. Employee Training - Employee training programs shall inform personnel at all levels of responsibility of the components and goals of the storm water pollution control plan. Training should address topics such as spill response, good housekeeping and material management practices. The plan shall identify periodic dates for such training.

8. Inspection Procedures - Qualified plant personnel shall be identified to inspect designated equipment and plant areas. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to an inspection. Inspections and maintenance activities shall be documented and recorded.

G. Non-Storm Water Discharge - The plan shall include a certification that the discharge has been tested or evaluated for the presence of non-storm water discharge. The certification shall include a description of any test for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Any facility that is unable to provide this certification must describe the procedure of any test conducted for the presence of non-storm water discharges, the test results, potential sources of non-storm water discharges to the storm sewer, and why adequate tests for such storm sewers were not feasible.

H. Quarterly Visual Observation of Discharges - The requirements and procedures for quarterly visual observations are applicable to all outfalls covered by this condition.

1. You must perform and document a quarterly visual observation of a storm water discharge associated with industrial activity from each outfall. The visual observation must be made during daylight hours. If no storm event resulted in runoff during daylight hours from the facility during a monitoring quarter, you are excused from the visual observations requirement for that quarter, provided you document in your records that no runoff occurred. You must sign and certify the document.

2. Your visual observation must be made on samples collected as soon as practical, but not to exceed 1 hour or when the runoff or snow melt begins discharging from your facility. All samples must be collected from a storm event discharge that is greater than 0.1 inch in magnitude and that occurs at least 72 hours from the previously measureable (greater than 0.1 inch rainfall) storm event. The observation must document: color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution. If visual observations indicate any unnatural color, odor, turbidity, floatable material, oil sheen or other indicators of storm water pollution, the permittee shall obtain a sample and monitor for the parameter or the list of pollutants in Part E.4.

3. You must maintain your visual observation reports onsite with the SWPPP. The report must include the observation date and time, inspection personnel, nature of the discharge (i.e., runoff or snow melt), visual quality of the storm water discharge (including observations of color, odor, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution), and probable sources of any observed storm water contamination.

4. You may exercise a waiver of the visual observation requirement at a facility that is inactive or unstaffed, as long as there are no industrial materials or activities exposed to storm water. If you exercise this waiver, you must maintain a certification with your SWPPP stating that the site is inactive and unstaffed, and that there are no industrial materials or activities exposed to storm water.

5. Representative Outfalls - If your facility has two or more outfalls that you believe discharge substantially identical effluents, based on similarities of the industrial activities, significant materials, size of drainage areas, and storm water management practices

Special Conditions

occurring within the drainage areas of the outfalls, you may conduct visual observations of the discharge at just one of the outfalls and report that the results also apply to the substantially identical outfall(s).

6. The visual observation documentation shall be made available to the Agency and general public upon written request.

I. The permittee shall conduct an annual facility inspection to verify that all elements of the plan, including the site map, potential pollutant sources, and structural and non-structural controls to reduce pollutants in industrial storm water discharges are accurate. Observations that require a response and the appropriate response to the observation shall be retained as part of the plan. Records documenting significant observations made during the site inspection shall be submitted to the Agency in accordance with the reporting requirements of this permit.

J. This plan should briefly describe the appropriate elements of other program requirements, including Spill Prevention Control and Countermeasures (SPCC) plans required under Section 311 of the CWA and the regulations promulgated there under, and Best Management Programs under 40 CFR 125.100.

K. The plan is considered a report that shall be available to the public at any reasonable time upon request.

L. The plan shall include the signature and title of the person responsible for preparation of the plan and include the date of initial preparation and each amendment thereto.

M. Facilities which discharge storm water associated with industrial activity to municipal separate storm sewers may also be subject to additional requirement imposed by the operator of the municipal system

Construction Authorization

Authorization is hereby granted to construct treatment works and related equipment that may be required by the Storm Water Pollution Prevention Plan developed pursuant to this permit.

This Authorization is issued subject to the following condition(s).

N. If any statement or representation is found to be incorrect, this authorization may be revoked and the permittee there upon waives all rights there under.

O. The issuance of this authorization (a) does not release the permittee from any liability for damage to persons or property caused by or resulting from the installation, maintenance or operation of the proposed facilities; (b) does not take into consideration the structural stability of any units or part of this project; and (c) does not release the permittee from compliance with other applicable statutes of the State of Illinois, or other applicable local law, regulations or ordinances.

P. Plans and specifications of all treatment equipment being included as part of the stormwater management practice shall be included in the SWPPP.

Q. Construction activities which result from treatment equipment installation, including clearing, grading and excavation activities which result in the disturbance of one acre or more of land area, are not covered by this authorization. The permittee shall contact the IEPA regarding the required permit(s).

REPORTING

R. The annual inspection report shall include results of the annual facility inspection which is required by Part I of this condition. The report shall also include documentation of any event (spill, treatment unit malfunction, etc.) which would require an inspection, results of the inspection, and any subsequent corrective maintenance activity. The report shall be completed and signed by the authorized facility employee(s) who conducted the inspection(s). The annual inspection report is considered a public document that shall be available at any reasonable time upon request.

S. The first report shall contain information gathered during the one year time period beginning with the October 1st of each year and shall be submitted no later than December 1st after this one year period has expired. Each subsequent report shall contain the previous year's information and shall be submitted no later December 1st of the following year.

T. If the facility performs inspections more frequently than required by this permit, the results shall be included as additional information in the annual report.

U. The permittee shall retain the annual inspection report on file at least 3 years. This period may be extended by request of the Illinois Environmental Protection Agency at any time.

Special Conditions

Annual inspection reports shall be submitted electronically at epa.npdes.inspection@illinois.gov or mailed to the following address:

Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
Annual Inspection Report
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

V. The permittee shall notify any regulated small municipal separate storm sewer owner (MS4 Community) that they maintain coverage under an individual NPDES permit. The permittee shall submit any SWPPP or any annual inspection to the MS4 community upon request by the MS4 community.

SPECIAL CONDITION 15. The Nuclear Regulatory Commission has required that Clinton Power Station obtain, train personnel in the usage of, and periodically test additional pumps which can be used in the event of emergencies to provide additional water to station equipment. The station is permitted to pump water from Clinton Lake at locations including, but not limited to, the Screen House and the Point and discharge to Clinton Lake at location including, but not limited to, the Screen House, the Point, and nearby ground surfaces. This is the testing of emergency pumps only, and during such activities, water will be pumped from Clinton Lake and returned directly to the Lake.

SPECIAL CONDITION 16. Fecal Coliform samples shall be obtained once per month during the months of May through October.

SPECIAL CONDITION 17. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving waters.

SPECIAL CONDITION 18. The use or operation of this facility shall be by or under the supervision of a Certified Class K operator.

SPECIAL CONDITION 19. If an applicable effluent standard or limitation is promulgated under Sections 301(b)(2)(c) and (d), 304(b)(2), and 307(a)(2) of the Clean Water Act and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the NPDES Permit, the Agency shall revise or modify the permit in accordance with the more stringent standard or prohibition and shall so notify the permittee.

SPECIAL CONDITION 20. This permit authorizes the use of water treatment additives that were requested as part of this renewal and water treatment additives that were previously approved by the Agency. The use of any new additives, or change in those previously approved by the Agency, or if the permittee increases the feed rate or quantity of the additives used beyond what has been approved by the Agency, the permittee shall request a modification of this permit in accordance with the Standard Conditions – Attachment H.

SPECIAL CONDITION 21. There shall be no discharge of complexed metal bearing wastestreams and associated rinses from chemical metal cleaning, unless this permit has been modified to include the new discharge.

SPECIAL CONDITION 22. There shall be no abnormal temperature changes that may adversely affect aquatic life, including but not limited to fish kills, unless caused by natural conditions. Appropriate corrective measures will be required if, upon complaint filed in accordance with Illinois Pollution Control Board rules, it is found at any time that any heated effluent causes significant ecological damage to the receiving stream.

Any planned plant shutdowns shall be conducted in a manner to minimize rapid temperature changes that may result in adverse aquatic life impacts such as temperature shock. The Illinois Department of Natural Resources Region III Office and the Illinois EPA Champaign Regional Office shall be notified of any planned plant shutdown due to a refueling outage one week prior to the shutdown occurring.

The Illinois Department of Natural Resources Region III Office and the Illinois EPA Champaign Regional Office shall be notified immediately if any fish kills are observed.

SPECIAL CONDITION 23. Monitoring for zinc shall only be required when using a corrosion inhibitor containing zinc.

SPECIAL CONDITION 24. Quarterly monitoring for phosphorus shall only be required when using a corrosion inhibitor containing phosphorus.

SPECIAL CONDITION 25. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. Code 302.

Special Conditions

SPECIAL CONDITION 26. A mixing zone for Zinc is recognized with dimensions extending 33 feet by 6.5 feet from the point of discharge at Outfall 007. Within the mixing zone 4:1 dilution is afforded. A zone of initial dilution (ZID) is recognized for Zinc with dimensions extending 7.1 feet by 1.6 feet from the point of discharge at Outfall 007. Within the mixing zone 3.3:1 dilution is afforded.

Attachment H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, 415 ILCS 5 as Amended.

Agency means the Illinois Environmental Protection Agency.

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24-Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8-Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply**. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirements.

(2) **Duty to reapply**. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense**. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate**. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance**. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions**. This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62 and 40 CFR 122.63. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights**. This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information**. The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry**. The permittee shall allow an authorized representative of the Agency or USEPA (including an authorized contractor acting as a representative of the Agency or USEPA), upon the presentation of credentials and other documents as may be required by law, to:
   (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records

must be kept under the conditions of this permit;

(b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

(c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and

(d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records.**

(a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

(b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. Records related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Agency or USEPA at any time.

(c) Records of monitoring information shall include:

(1) The date, exact place, and time of sampling or measurements;

(2) The individual(s) who performed the sampling or measurements;

(3) The date(s) analyses were performed;

(4) The individual(s) who performed the analyses;

(5) The analytical techniques or methods used; and

(6) The results of such analyses.

(d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement.** All applications, reports or information submitted to the Agency shall be signed and certified.

(a) **Application.** All permit applications shall be signed as follows:

(1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation:

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.

(b) **Reports.** All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described in paragraph (a); and

(2) The authorization specifies either an individual or a position responsible for the overall operation of the facility, from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility; and

(3) The written authorization is submitted to the Agency.

(c) Changes of Authorization. If an authorization under (b) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of (b) must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.

(d) **Certification.** Any person signing a document under paragraph (a) or (b) of this section shall make the following certification:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(12) **Reporting requirements.**

(a) **Planned changes.** The permittee shall give notice to the Agency as soon as possible of any planned physical alterations or additions to the permitted facility.
Notice is required when:

(1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source pursuant to 40 CFR 122.29 (b); or

(2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements pursuant to 40 CFR 122.42 (a)(1).

(3) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

(b) **Anticipated noncompliance.** The permittee shall give advance notice to the Agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

(c) **Transfers.** This permit is not transferable to any person except after notice to the Agency.

(d) **Compliance schedules.** Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

(e) **Monitoring reports.** Monitoring results shall be reported at the intervals specified elsewhere in this permit.

(1) Monitoring results must be reported on a Discharge Monitoring Report (DMR).

(2) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.

(3) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Agency in the permit.

(f) **Twenty-four hour reporting**. The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24-hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and time; and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The following shall be included as information which must be reported within 24-hours:

(1) Any unanticipated bypass which exceeds any effluent limitation in the permit.

(2) Any upset which exceeds any effluent limitation in the permit.

(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Agency in the permit or any pollutant which may endanger health or the environment.

The Agency may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

(g) **Other noncompliance**. The permittee shall report all instances of noncompliance not reported under paragraphs (12) (d), (e), or (f), at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (12) (f).

(h) **Other information**. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to the Agency, it shall promptly submit such facts or information.

(13) **Bypass.**

(a) Definitions.

(1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

(2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(b) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (13)(c) and (13)(d).

(c) Notice.

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (12)(f) (24-hour notice).

(d) Prohibition of bypass.

(1) Bypass is prohibited, and the Agency may take enforcement action against a permittee for bypass, unless:

(i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(iii) The permittee submitted notices as required under paragraph (13)(c).

(2) The Agency may approve an anticipated bypass, after considering its adverse effects, if the Agency determines that it will meet the three conditions listed above in paragraph (13)(d)(1).

(14) **Upset**.

(a) Definition. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (14)(c) are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated; and

(3) The permittee submitted notice of the upset as required in paragraph (12)(f)(2) (24-hour notice).

(4) The permittee complied with any remedial measures required under paragraph (4).

(d) Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

(15) **Transfer of permits**. Permits may be transferred by modification or automatic transfer as described below:

(a) Transfers by modification. Except as provided in paragraph (b), a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued pursuant to 40 CFR 122.62 (b) (2), or a minor modification made pursuant to 40 CFR 122.63 (d), to identify the new permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

(b) Automatic transfers. As an alternative to transfers under paragraph (a), any NPDES permit may be automatically transferred to a new permittee if:
(1) The current permittee notifies the Agency at least 30 days in advance of the proposed transfer date;
(2) The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage and liability between the existing and new permittees; and
(3) The Agency does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement.

(16) All manufacturing, commercial, mining, and silvicultural dischargers must notify the Agency as soon as they know or have reason to believe:
(a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant identified under Section 307 of the Clean Water Act which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:
(1) One hundred micrograms per liter (100 ug/l);
(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4,6 dinitrophenol; and one milligram per liter (1 mg/l) for antimony.
(3) Five (5) times the maximum concentration value reported for that pollutant in the NPDES permit application; or
(4) The level established by the Agency in this permit.
(b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the NPDES permit application.

(17) All Publicly Owned Treatment Works (POTWs) must provide adequate notice to the Agency of the following:
(a) Any new introduction of pollutants into that POTW from an indirect discharge which would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and
(b) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.
(c) For purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(18) If the permit is issued to a publicly owned or publicly regulated treatment works, the permittee shall require any industrial user of such treatment works to comply with federal requirements concerning:
(a) User charges pursuant to Section 204 (b) of the Clean Water Act, and applicable regulations appearing in 40 CFR 35;
(b) Toxic pollutant effluent standards and pretreatment standards pursuant to Section 307 of the Clean Water Act; and
(c) Inspection, monitoring and entry pursuant to Section 308 of the Clean Water Act.

(19) If an applicable standard or limitation is promulgated under Section 301(b)(2)(C) and (D), 304(b)(2), or 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit, or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked, and reissued to conform to that effluent standard or limitation.

(20) Any authorization to construct issued to the permittee pursuant to 35 Ill. Adm. Code 309.154 is hereby incorporated by reference as a condition of this permit.

(21) The permittee shall not make any false statement, representation or certification in any application, record, report, plan or other document submitted to the Agency or the USEPA, or required to be maintained under this permit.

(22) The Clean Water Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318 or 405 of the Clean Water Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than one year, or both.
Additional penalties for violating these sections of the Clean Water Act are identified in 40 CFR 122.41 (a)(2) and (3).

(23) The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

(24) The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

(25) Collected screening, slurries, sludges, and other solids shall be disposed of in such a manner as to prevent entry of those wastes (or runoff from the wastes) into waters of the State. The proper authorization for such disposal shall be obtained from the Agency and is incorporated as part hereof by reference.

(26) In case of conflict between these standard conditions and any other condition(s) included in this permit, the other condition(s) shall govern.

(27) The permittee shall comply with, in addition to the requirements of the permit, all applicable provisions of 35 Ill. Adm. Code, Subtitle C, Subtitle D, Subtitle E, and all applicable orders of the Board or any court with jurisdiction.

(28) The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit is held invalid, the remaining provisions of this permit shall continue in full force and effect.

Attachment C: Threatened and Endangered Species Consultation Letters

Constellation.

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-008

Mr. Bradley Hayes
Acting Manager, Impact Assessment Section
Division of Real Estate Services and Consultation
Office of Realty and Environmental Planning
Illinois Department of Natural Resources (IDNR)
1 Natural Resources Way
Springfield, IL 62702

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Listed Species and Sensitive Habitats Review

Dear Mr. Hayes:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact federal- or state-listed species, and important plant and animal habitats, including critical habitats as defined by the Endangered Species Act and essential fish habitats as identified under the Magnuson-Stevens Fishery Conservation and Management Act. In addition, the NRC may request an informal or formal consultation with your agency.

This letter seeks input from the Illinois Department of Natural Resources (IDNR) regarding the effects that license renewal activities may have on listed species (or candidates proposed for listing) and important plant habitats within the station's environs and any questions or additional information necessary for the consultation process.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. The site encompasses the Clinton Lake State Recreation Area leased to and operated by the IDNR. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the unit's 6-mile vicinity (Figure 1), and a table of species potentially occurring within DeWitt County that are listed as federally, or state threatened or endangered in DeWitt County (Table 1) is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. Additionally, CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any listed species or sensitive habitats.

As stated above, this letter seeks your input on the proposed continued operation of CPS regarding listed species and important habitats within the environs of the station. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER. CEG would also welcome confirmation of our conclusion that the CPS license renewal would not adversely affect listed species or sensitive habitats.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:49:10 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosures:
Table 1: Threatened or Endangered Species Occurring Within DeWitt County, Illinois
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Table 1
Threatened or Endangered Species Occurring Within DeWitt County, Illinois

Common Name	Scientific Name	Legal Status
Plants		
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	FT
Mussels		
Spike	*Elliptio dilatatus*	SE
Monkeyface	*Theliderma metanevra*	ST
Insects		
Rusty Patched Bumble Bee	*Bombus affinis*	FE/SE
Monarch Butterfly	*Danaus plexippus*	FC
Fish		
American Brook Lamprey	*Lampetra appendix*	ST
Reptiles		
Kirtland's Snake	*Clonophis kirtlandii*	ST
Birds		
Northern Harrier	*Circus cyaneus*	SE
Mammals		
Indiana Bat	*Myotis sodalis*	FE
Northern Long-eared Bat	*Myotis septentrionalis*	FT

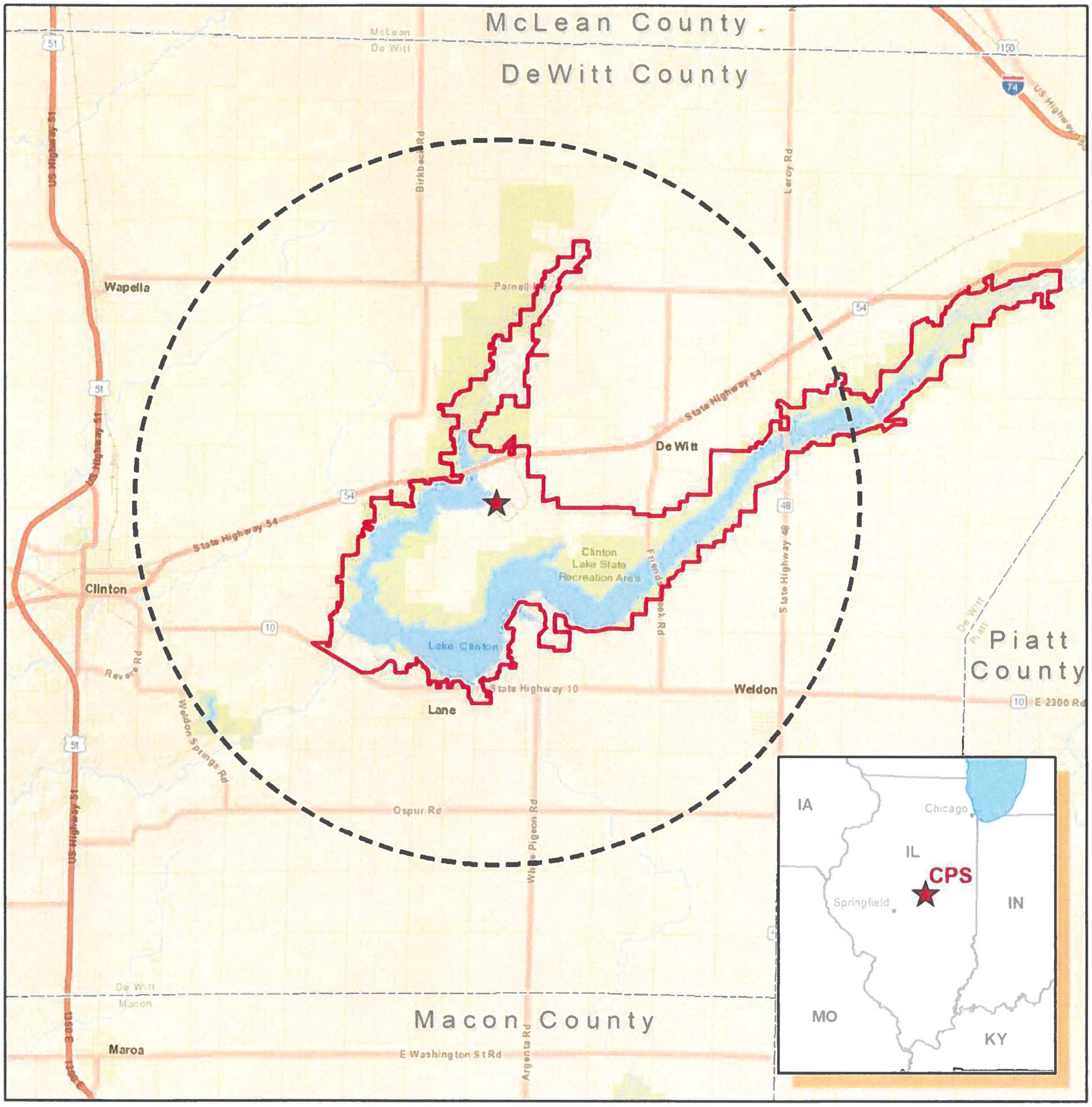
FE = federally endangered; FT = federally threatened; SE = state endangered; ST = state threatened; FC = federal candidate species

Table 1 Sources:

Illinois Department of Natural Resources (IDNR) 2022 Illinois Threatened and Endangered Species by County retrieved from the IDNR website at: <https://www2.illinois.gov/dnr/ESPB/Documents/ET%20List%20Review%20and%20Revision/ETCountyList.pdf> (accessed September 9, 2022)

U.S. Fish and Wildlife Service (USFWS) 2022 IPaC Resource List retrieved from the USFWS website at: <https://ipac.ecosphere.fws.gov/location/L3DJKBSMG5FPLDUMJEVJI7ML7M/resources#endangered-species> (accessed September 9, 2022).

Figure 1
Clinton Power Station Site



Legend

CPS

CPS Outer Site Boundary

CPS 6-Mile Radius

Miles
0 1 2

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-015

Ms. Kristen Lundh
USFWS Illinois-Iowa Ecological Field Services Office
1511 47th Ave.
Moline, IL 61265

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Listed Species and Sensitive Habitats Review

Dear Ms. Lundh:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact species listed or proposed for listing as threatened or endangered in accordance with the Endangered Species Act (ESA), and important plant and animal habitats, including critical habitats as defined by the ESA and essential fish habitat as identified under the Magnuson-Stevens Fishery Conservation and Management Act. In addition, the NRC may request an informal or formal consultation with your agency.

This letter seeks input from the U.S. Fish and Wildlife Service (USFWS) regarding the effects that license renewal activities may have on listed species (or candidates proposed for listing) and important plant habitats within the station's environs and any questions or additional information necessary for the consultation process.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. The site encompasses the Clinton Lake State Recreation Area leased to and operated by the Illinois Department of Natural Resources. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the unit's 6-mile vicinity (Figure 1), and a table of species potentially occurring within DeWitt County that are listed as federally, or state threatened or endangered in DeWitt County (Table 1) is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. Additionally, CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any listed species or sensitive habitats.

As stated above, this letter seeks your input on the proposed continued operation of CPS regarding listed species and important habitats within the environs of the station. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER. CEG would also welcome confirmation of our conclusion that the CPS license renewal would not adversely affect listed species or sensitive habitats.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

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Date: 2023.01.18 14:37:21 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosures:
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bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
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Constellation Document Control Desk Licensing

Table 1
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Monkeyface	*Theliderma metanevra*	ST
Insects		
Rusty Patched Bumble Bee	*Bombus affinis*	FE/SE
Monarch Butterfly	*Danaus plexippus*	FC
Fish		
American Brook Lamprey	*Lampetra appendix*	ST
Reptiles		
Kirtland's Snake	*Clonophis kirtlandii*	ST
Birds		
Northern Harrier	*Circus cyaneus*	SE
Mammals		
Indiana Bat	*Myotis sodalis*	FE
Northern Long-eared Bat	*Myotis septentrionalis*	FT

FE = federally endangered; FT = federally threatened; SE = state endangered; ST = state threatened; FC = federal candidate species

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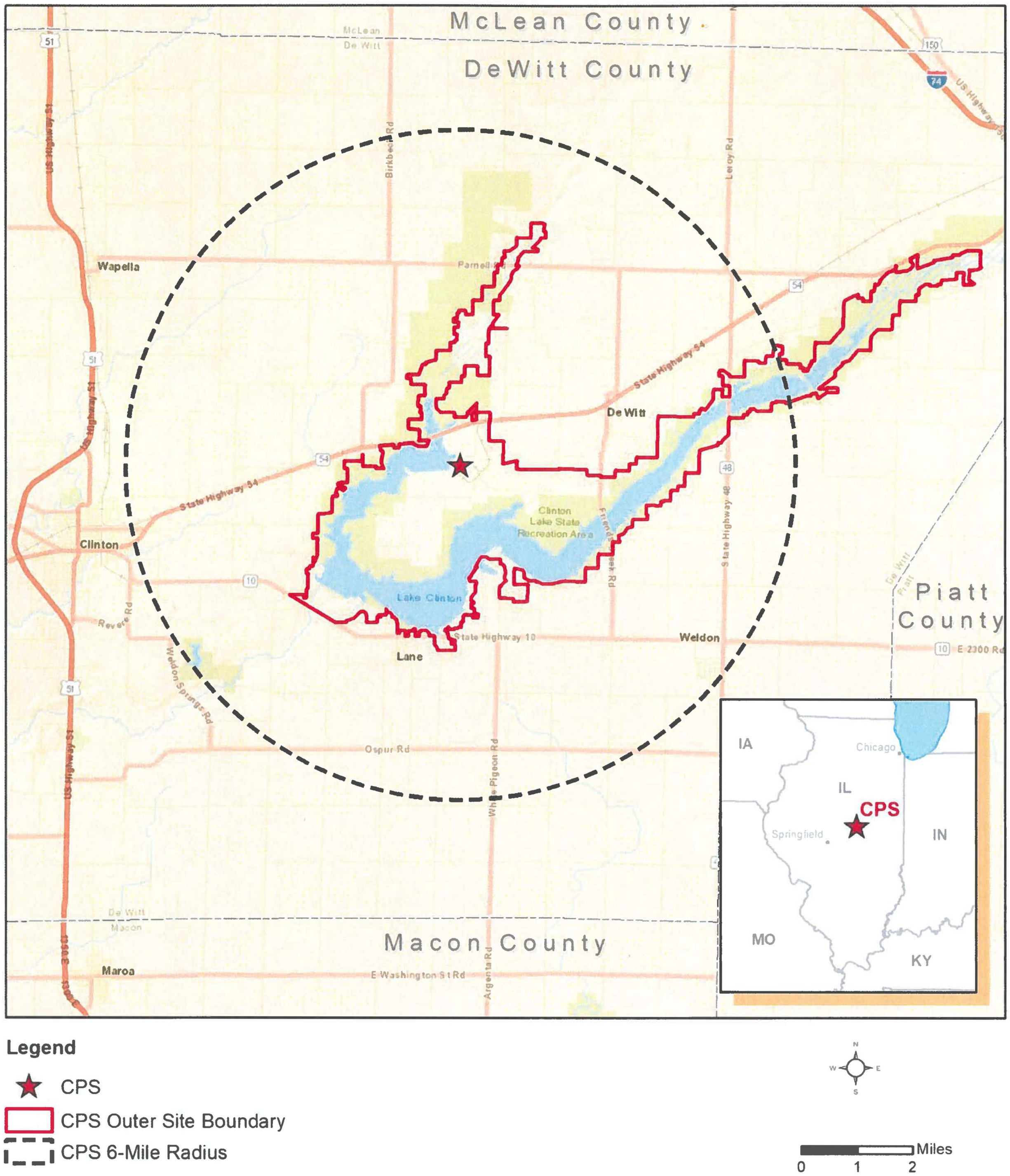
Figure 1
Clinton Power Station Site



Attachment D: Cultural Resources Consultation Letters

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-010

Mr. Jeff Kruchten, Chief Archaeologist
Illinois State Historic Preservation Office
1 Old State Capital Plaza
Springfield, IL 62701

Subject: Constellation Energy Generation – Clinton Power Station Unit 1 License Renewal Request for Historic and Cultural Resources Review

Dear Mr. Krutchen:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact historic and cultural resources including tribal cultural properties on or near the CPS site. While the potential for cultural impacts of the existing facility were assessed during original licensing, and license renewal is unlikely to have significant additional or different impacts, as part of the renewal process, the NRC may request consultation in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470), and the federal Advisory Council on Historic Preservation regulations (36 CFR 800) with your agency regarding the license renewal.

This letter seeks input from the Illinois State Historic Preservation Office regarding potential effects that license renewal activities may have on historic cultural resources, including tribal cultural properties.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. The site encompasses the Clinton Lake State Recreation Area leased to and operated by the Illinois Department of Natural Resources. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the vicinity within a 6-mile radius of the unit (Figure 1) and a table of known archaeological sites and historic properties in the station's vicinity (Tables 1 and 2) are enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. Currently, CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any cultural or historic resources.

As stated above, this letter seeks your input on the proposed continued operation of CPS on historic and cultural resources, including tribal cultural resources, within the environs of the station. CEG would appreciate any comments, concerns or information you believe should be considered in the preparation of the ER. CEG would also welcome confirmation of our conclusion that the CPS license renewal would not adversely affect historic or cultural resources.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:47:45 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosures:

Table 1: Illinois Inventory of Archaeological Sites Within 6 Miles of CPS
Table 2: Illinois Department of Natural Resources – Historic Conservation Division Historic Structures Entries within 6 miles of CPS
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 1 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW5	Dewitt	Prehistoric mound site	Protected by HSRPA Burial Law
11DW6	Dewitt	Prehistoric battle site	Unassessed
11DW10	Maroa	Paleo habitation site	Unassessed Recommended for Phase II testing
11DW13	Maroa	Late Archaic habitation site	Unassessed
11DW14	Clinton	Unassigned Prehistoric site	Unassessed
11DW15	Dewitt	Late Archaic site	Phase III completed
11DW20	Farmer City South	Unassigned Archaic site N=25	Unassessed
11DW25	Dewitt	Early Archaic habitation site N=3	Unassessed
11DW26	Dewitt	Woodland habitation site	Unassessed
11DW27	Dewitt	Unassigned prehistoric habitation site (N=16)	Unassessed
11DW35	Farmer City South	Unassigned prehistoric habitation site(N=82)	Unassessed
11DW63	Maroa	Unassigned prehistoric lithic scatter (N=4)	Unassessed
11DW64	Dewitt	Early to Middle Archaic habitation site N=13	Unassessed
11DW65	Farmer City South	Unassigned prehistoric habitation site N=10	Unassessed
11DW95	Clinton	Unassigned prehistoric habitation site N=2	Unassessed
11DW96	Clinton	Unassigned Archaic processing camp N=2	Unassessed
11DW97	Dewitt	Middle to Late Archaic habitation site N=5	Unassessed
11DW98	Dewitt	Early Archaic habitation site (base camp) N=37	Unassessed
11DW108	Dewitt	Unassigned prehistoric processing camp N=3	Unassessed
11DW109	Dewitt	Unassigned prehistoric habitation site N=3	Unassessed
11DW110	Dewitt	Unassigned prehistoric processing camp N=3	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 2 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW145	Dewitt	Unassigned prehistoric lithic scatter N=11	Not eligible
11DW147	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW148	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW149	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW150	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW151	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW152	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW153	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW154	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW155	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW156	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW157	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW158	Dewitt	Early Archaic lithic scatter	Unassessed
11DW159	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW160	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW161	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW162	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW163	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW164	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW165	Dewitt	Unassigned prehistoric lithic scatter	Unassessed

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW166	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW167	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW168	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW169	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW170	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW171	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW172	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW173	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW174	Perry	Unassigned prehistoric lithic scatter	Unassessed
11DW175	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW176	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW177	Dewitt	Unassigned Archaic lithic scatter	Unassessed
11DW178	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW179	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW180	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW181	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW182	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW183	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW184	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW185	Dewitt	Unassigned prehistoric lithic scatter	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 4 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW186	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW187	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW188	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW189	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW190	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW191	Dewitt	Late Woodland lithic scatter	Unassessed
11DW192	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW193	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW194	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW195	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW196	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW197	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW198	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW199	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW200	Dewitt	Isolated find of an unassigned prehistoric lithic drill fragment	Unassessed
11DW201	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW202	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW203	Dewitt	Unassigned prehistoric lithic scatter (no cultural material listed)	Unassessed
11DW204	Dewitt	Unassigned prehistoric lithic scatter	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 5 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW205	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW206	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW207	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW208	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW209	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW210	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW211	Dewitt	Late Archaic lithic scatter	Unassessed
11DW212	Dewitt	Early Archaic lithic scatter	Unassessed
11DW213	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW215	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW217	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW218	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW219	Dewitt	Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW220	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW221	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW222	Dewitt	Early Archaic and Late Woodland lithic scatter	Determined not eligible after Phase II testing
11DW223	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW224	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW225	Dewitt	Unassigned Woodland lithic scatter with shell fragments	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 6 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW226	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW227	Dewitt	Unassigned lithic scatter with shell fragments	Unassessed
11DW228	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW229	Dewitt	Middle to Late Archaic lithic scatter	Recommended for Phase II Testing/Unassessed
11DW230	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW231	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW232	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW233	Dewitt	Early Archaic lithic scatter	Unassessed
11DW234	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW235	Dewitt	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW236	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW237	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW238	Dewitt	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW239	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW240	Dewitt	Unassigned Woodland lithic scatter	Determined not eligible after Phase II testing
11DW241	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW242	Dewitt	Middle to Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW243	Dewitt	Early Archaic and Middle Woodland lithic scatter	Determined not eligible after Phase II testing
11DW244	Dewitt	Unassigned Woodland lithic scatter with shell	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 7 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW245	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW246	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW247	Dewitt	Middle to Late Archaic lithic scatter	Unassessed
11DW248	Dewitt	Middle to Late Archaic lithic scatter	Determined not eligible after Phase II testing
11DW249	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW250	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW251	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW252	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW253	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW254	Dewitt	Unassigned Archaic lithic scatter	Unassessed
11DW255	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW256	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW257	Dewitt	Unassigned prehistoric lithic scatter	Unassessed
11DW258	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW259	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW260	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW261	Clinton	Unassigned prehistoric lithic scatter with shell	Unassessed
11DW262	Clinton	Late Archaic camp	Determined not eligible after Phase II testing
11DW263	Clinton	Unassigned prehistoric lithic scatter	Unassessed
11DW264	Clinton	Unassigned prehistoric village or camp	Unassessed

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 8 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW272	Farmer City South	Unassigned prehistoric lithic scatter	Unassessed
11DW273	Farmer City South	Unassigned prehistoric lithic scatter	Unassessed
11DW274	Farmer City South	Middle to Late Archaic lithic scatter	Unassessed
11DW284	Maroa	Middle Archaic lithic scatter	Determined not eligible after Phase II testing
11DW285	Clinton	Unassigned historic period habitation site	Unassessed
11DW286	Dewitt	Unassigned prehistoric lithic scatter and a spent bullet N=18	Determined not eligible after Phase II testing
11DW287	Dewitt	Late Woodland to Mississippian habitation site, with a historic period crockery sherd N=32	Determined not eligible after Phase II testing
11DW288	Dewitt	Unassigned prehistoric lithic flake and two whiteware fragments N=3	Not eligible
11DW289	Dewitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW290	Dewitt	Unassigned prehistoric lithic scatter with two fragments of 20th century crockery N=38	Determined not eligible after Phase II testing
11DW291	Dewitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW292	Dewitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW293	Dewitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW294	Dewitt	Early Archaic lithic scatter N=20	Determined not eligible after Phase II testing
11DW295	Dewitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW296	Dewitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW297	Dewitt	Unassigned prehistoric lithic scatter N=8	Not eligible

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 9 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW298	Dewitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW299	Dewitt	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW300	Dewitt	Unassigned prehistoric lithic scatter	Not eligible
11DW301	Dewitt	Multicomponent prehistoric lithic scatter N=13 1870s to 1920 debris scatter with a concrete foundation N=over 130	Not eligible
11DW302	Dewitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW303	Dewitt	Late Archaic habitation site N=14	Determined not eligible after Phase II testing
11DW304	Dewitt	Early to mid-20th century glass and ceramic scatter N=14, with brick, concrete and glazed tile fragments	Not eligible
11DW305	Dewitt	Early Archaic and Late Woodland habitation and lithic scatter N=10	Determined not eligible after Phase II testing
11DW306	Dewitt	Middle Archaic lithic scatter N=3	Determined not eligible after Phase II testing
11DW307	Dewitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW308	Dewitt	Late Archaic lithic scatter N=5	Determined not eligible after Phase II testing
11DW309	Dewitt	Unassigned prehistoric lithic scatter N=8	Not eligible
11DW310	Dewitt	Unassigned prehistoric lithic scatter N=3	Not eligible
11DW311	Dewitt	Multicomponent site; prehistoric lithic scatter N=14, 1870s to 1920 glass and ceramic scatter with a brick and concrete fragments N=over 400	Determined not eligible after Phase II testing

Table 1
Illinois Inventory of Archaeological Sites Within 6 Miles of CPS[a] (Page 10 of 10)

IIAS Trinomial	Quadrangle	Site Type	NRHP Status
11DW312	Dewitt	Unassigned prehistoric lithic scatter with one glazed brick/tile N=5	Not eligible
11DW313	Dewitt	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW351	Maroa	An isolated find of one core N=1	Not eligible
11DW352	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW353	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW354	Maroa	Early, Middle, and Late Archaic site N=67	Recommended for Phase II testing
11DW355	Maroa	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW356	Maroa	Unassigned prehistoric lithic scatter N=4	Not eligible
11DW357	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW359	Dewitt	Unassigned prehistoric habitation site/lithic scatter N=9	Not eligible
11DW360	Dewitt	Late 19th to late 20th century artifact scatter N=6	Not eligible
11DW362	Maroa	Unassigned prehistoric lithic scatter N=2	Not eligible
11DW364	Maroa	Springhead box and 1871 to 1945 artifacts N=5	Not eligible
11DW424	Clinton	Cundiff Cemetery with headstones from 1840 to 1869	Protected by HSRPA Burial Law

IIAS = Illinois Inventory of Archaeological Sites

NRHP = National Register of Historic Properties

Note:

a. The Illinois Inventory of Archaeological Sites was also consulted in the development of this table.

Source: Illinois Historic & Architectural Resources Geographic Information System (HARGIS) 2022 retrieved from website at: <https://maps.dnr.illinois.gov/portal/apps/webappviewer/index.html?id=8f6e15ca8973412bbd534e6990da752d> (accessed October 31, 2022).

Table 2
Illinois Department of Natural Resources – Historic Conservation Division Historic Structures Entries Within 6 Miles of CPS[a]

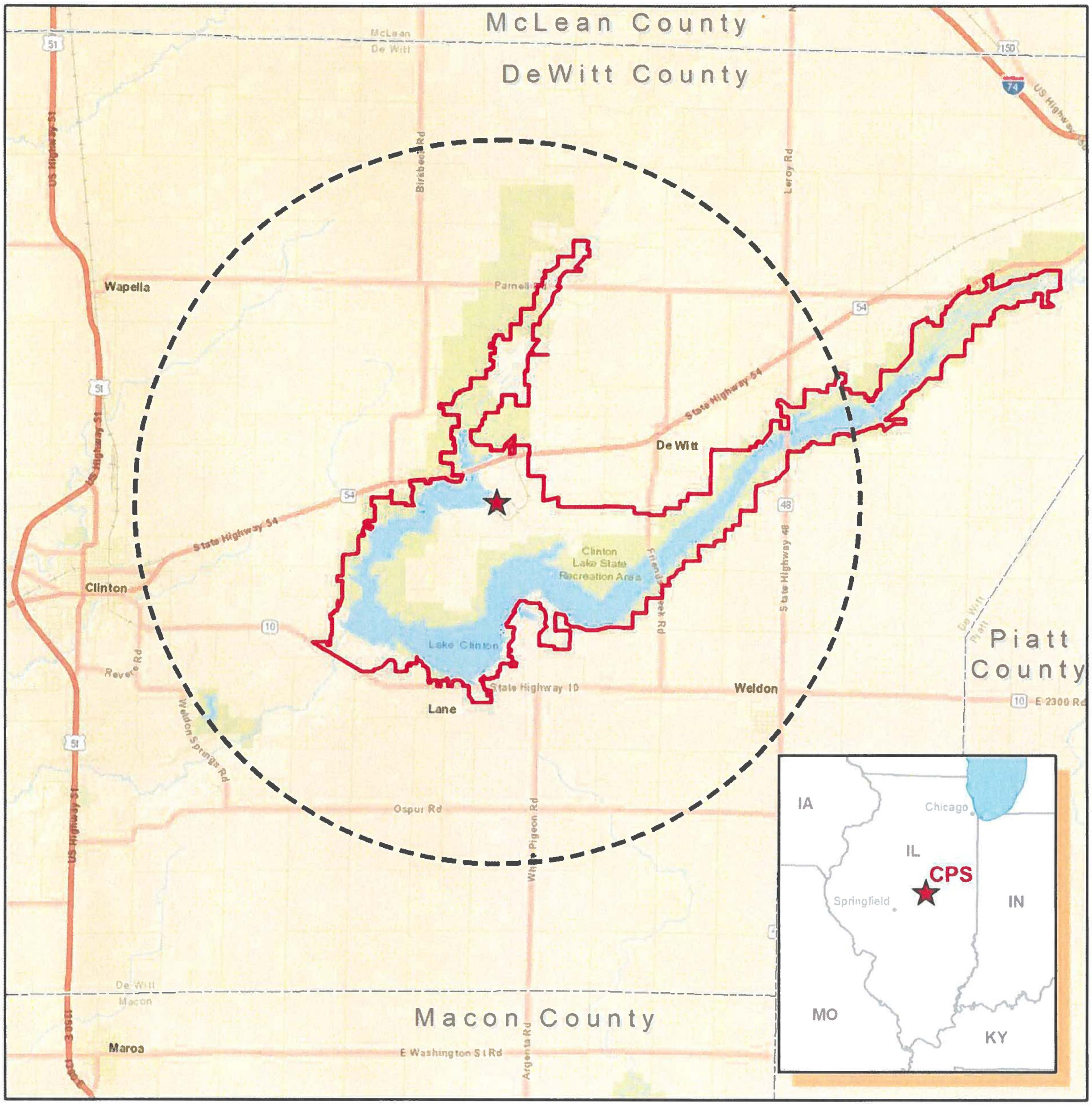
IHPD #	Historical Name	Historical Use	NRHP Status	Distance from CPS[b]
303254	Harp Township Hall	Community Building	Undetermined	1.74 miles
303255	Centennary Methodist Episcopal Church	Church	Undetermined	1.65 miles
303262	Prairie Center Methodist Church	Church	Undetermined	4.52 miles
303277	NA	Unidentified (possible church)	Undetermined	2.66 miles
303280	NA	Single Dwelling	Undetermined	2.70 miles
303282	Weldon Springs Conservation Area	Recreational Park	Undetermined	5.80 miles
303284	NA	Single Dwelling	Undetermined	5.81 miles
303294	Bank of Lane	Single Dwelling	Undetermined	3.64 miles
303295	Lane School	School	Undetermined	3.48 miles
303296	Prairie Center Methodist Church World War I Memorial	Memorial	Undetermined	4.54 miles
303299	Field Piece	Artillery Field Piece	Undetermined	5.84 miles
303300	World War II Memorial	Memorial	Undetermined	5.83 miles
303301	World War I Memorial	Memorial	Undetermined	5.82 miles
303302	Cyrus Hall Memorial Gate	Memorial	Undetermined	5.84 miles
303307	NA	Single Dwelling	Undetermined	3.59 miles

Notes:

a. The Illinois Inventory of Archeological Sites was also consulted in the development of this table.
b. Distances are approximate and based on the CPS unit one center point and IHPD-Historic Architectural Resources Geographic Information System location data.

Source: Illinois Historic & Architectural Resources Geographic Information System (HARGIS). 2022 retrieved from website at: <https://maps.dnr.illinois.gov/portal/apps/webappviewer/index.html?id=8f6e15ca8973412bbd534e6990da752d> (Accessed October 31, 2022).

Figure 1
Clinton Power Station Site



Legend

★ CPS

CPS Outer Site Boundary

CPS 6-Mile Radius

Miles
0 1 2

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-011

Mr. Lester Randall, Chairman
Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas
824 111th Drive
Horton, KS 66438

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Tribal Review

Dear Mr. Randall:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact historic and cultural resources, including tribal cultural properties on or near the CPS site. While the potential for cultural impacts of the existing facility were assessed during original licensing, and license renewal is unlikely to have significant additional or different impacts, the NRC may request a consultation with the Illinois State Historic Preservation Office and your tribe regarding the license renewal.

This letter seeks input from the Kickapoo Tribe in Kansas regarding the effects that license renewal activities may have on tribal cultural properties within the station's surrounding area, and confirmation from you that, absence of ground disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations and no refurbishment, there will be no anticipated impacts to tribal cultural properties within the station's environs due to continued operation of CPS.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the vicinity within a 6-mile radius of the station is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any cultural or historic resources.

As stated above, this letter seeks your input regarding tribal cultural properties within the station's surrounding area, and confirmation that there will be no anticipated impacts to tribal cultural properties within the station's environs. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:46:47 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosure:
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
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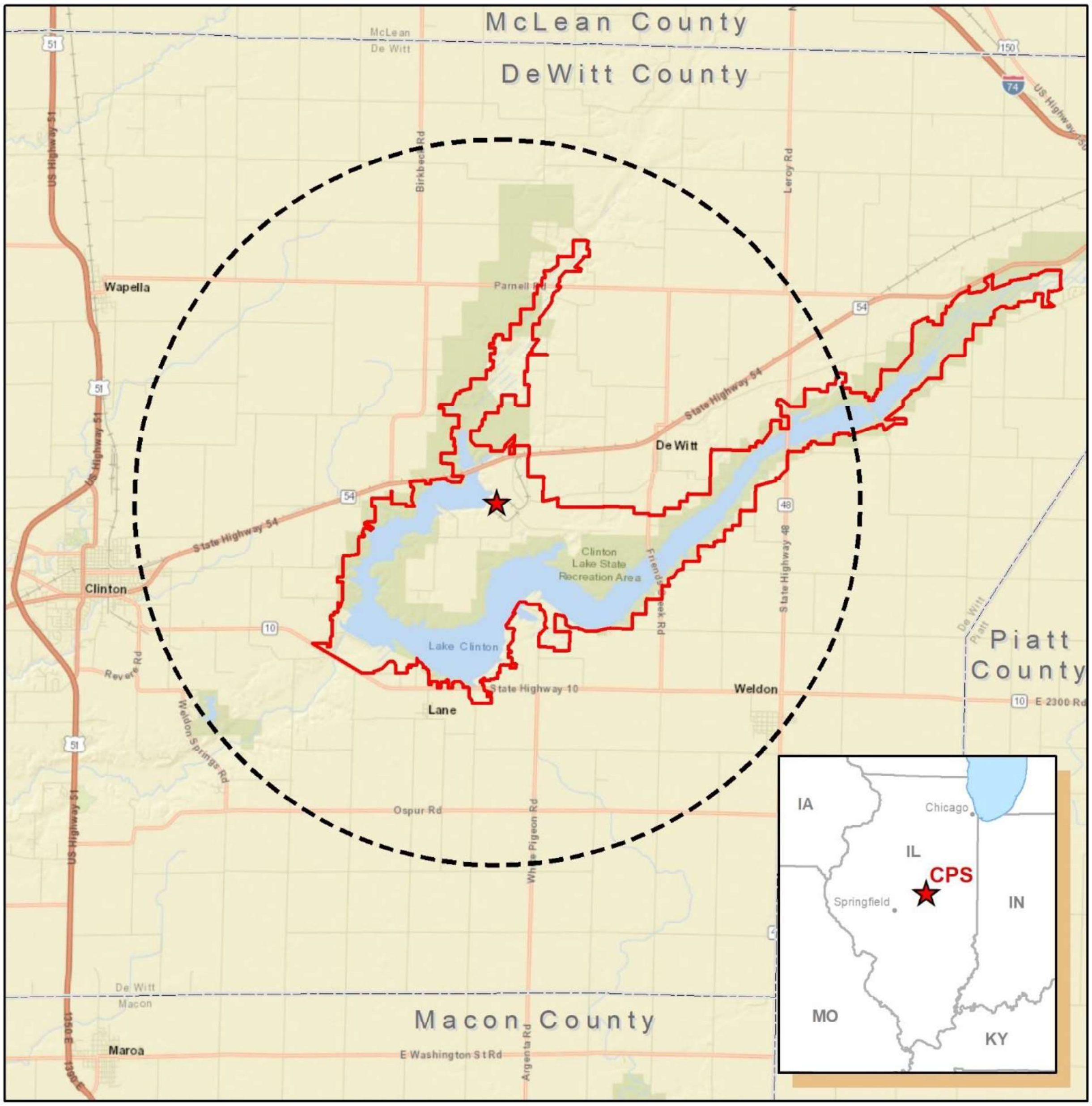
Constellation Document Control Desk Licensing

Figure 1
Clinton Power Station Site



Legend

★ CPS

CPS Outer Site Boundary

CPS 6-Mile Radius

Miles
0 1 2

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-012

Mr. Kent Collier
Kickapoo Tribe of Oklahoma
P.O. Box 70
McLoud, OK 74851

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Tribal Review

Dear Mr. Collier:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact historic and cultural resources, including tribal cultural properties on or near the CPS site. While the potential for cultural impacts of the existing facility were assessed during original licensing, and license renewal is unlikely to have significant additional or different impacts, the NRC may request a consultation with the Illinois State Historic Preservation Office and your tribe regarding the license renewal.

This letter seeks input from the Kickapoo Tribe in Oklahoma regarding the effects that license renewal activities may have on tribal cultural properties within the station's surrounding area, and confirmation from you that, absence of ground disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations and no refurbishment, there will be no anticipated impacts to tribal cultural properties within the station's environs due to continued operation of CPS.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the vicinity within a 6-mile radius of the station is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any cultural or historic resources.

As stated above, this letter seeks your input regarding tribal cultural properties within the station's surrounding area, and confirmation that there will be no anticipated impacts to tribal cultural properties within the station's environs. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

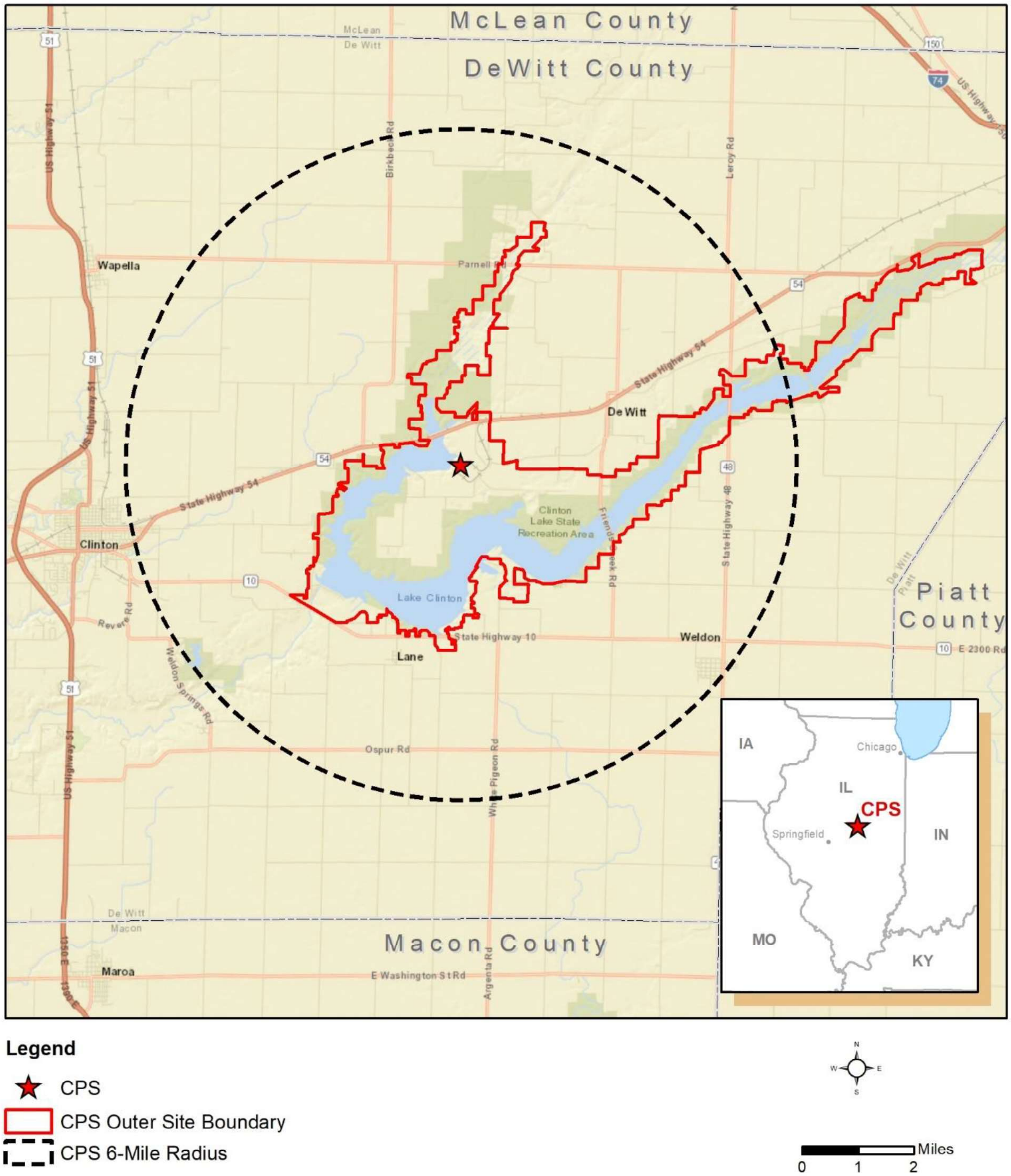
Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:45:51 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosure:
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Figure 1
Clinton Power Station Site



Constellation
200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-013

Mr. David Grignon, THPO
Menominee Indian Tribe of Wisconsin
P.O. Box 910
Keshena, WI 54135-0910

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Tribal Review

Dear Mr. Grignon:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact historic and cultural resources, including tribal cultural properties on or near the CPS site. While the potential for cultural impacts of the existing facility were assessed during original licensing, and license renewal is unlikely to have significant additional or different impacts, the NRC may request a consultation with the Illinois State Historic Preservation Office and your tribe regarding the license renewal.

This letter seeks input from the Menominee Indian Tribe of Wisconsin regarding the effects that license renewal activities may have on tribal cultural properties within the station's surrounding area, and confirmation from you that, absence of ground disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations and no refurbishment, there will be no anticipated impacts to tribal cultural properties within the station's environs due to continued operation of CPS.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the vicinity within a 6-mile radius of the station is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any cultural or historic resources.

As stated above, this letter seeks your input regarding tribal cultural properties within the station's surrounding area, and confirmation that there will be no anticipated impacts to tribal cultural properties within the station's environs. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

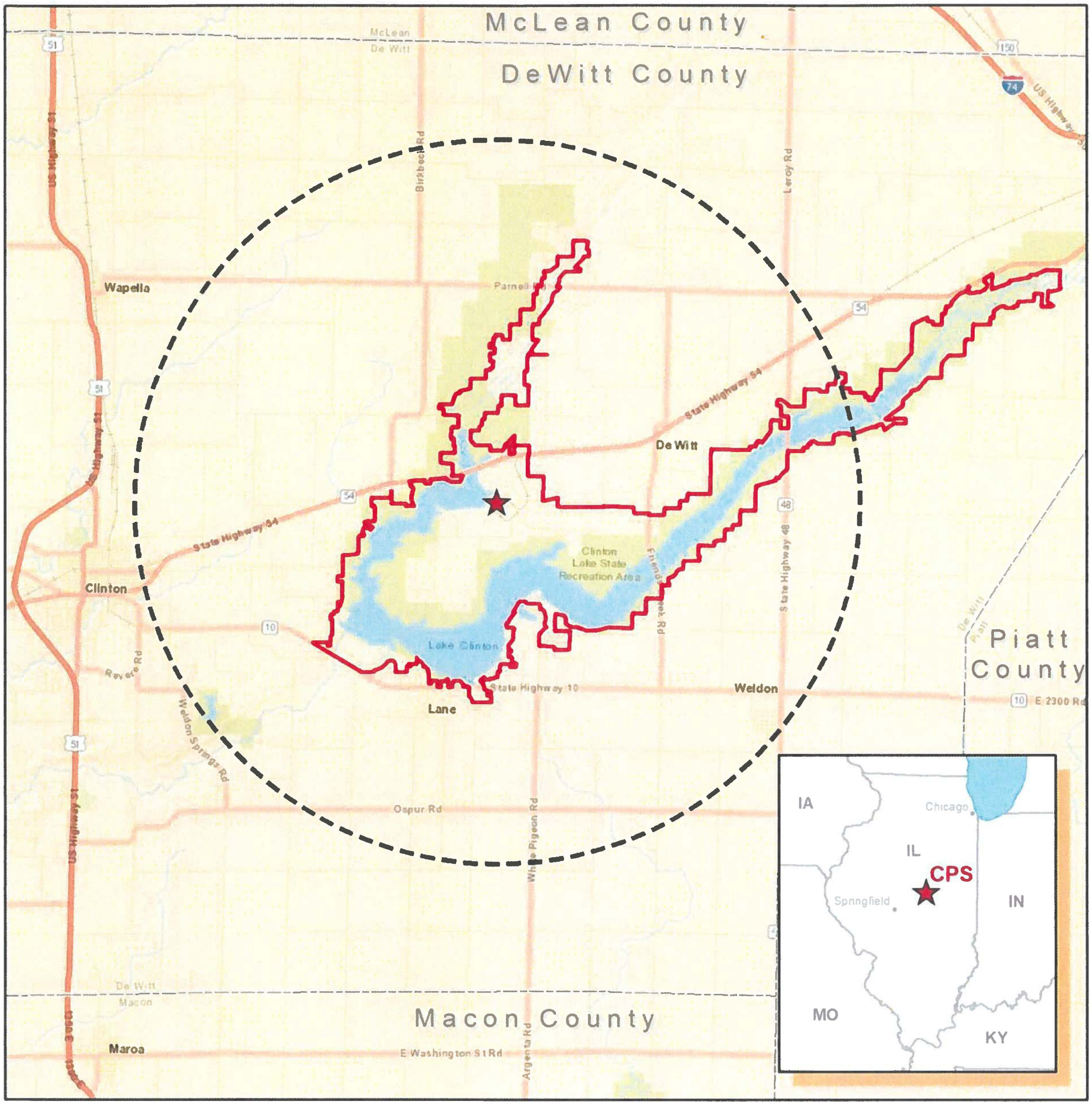
Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:45:12 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosure:
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Figure 1
Clinton Power Station Site



Legend

CPS

CPS Outer Site Boundary

CPS 6-Mile Radius

Miles
0 1 2

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-014

Ms. Diane Hunter, THPO
Miami Tribe of Oklahoma
P.O. Box 1326
Miami, OK 74355

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Tribal Review

Dear Ms. Hunter:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the license renewal application include an environmental report (ER) that assesses the impacts from continued operation and any refurbishment to be undertaken to enable the continued operation of the unit. The ER addresses the potential to impact historic and cultural resources, including tribal cultural properties on or near the CPS site. While the potential for cultural impacts of the existing facility were assessed during original licensing, and license renewal is unlikely to have significant additional or different impacts, the NRC may request a consultation with the Illinois State Historic Preservation Office and your tribe regarding the license renewal.

This letter seeks input from the Miami Tribe of Oklahoma regarding the effects that license renewal activities may have on tribal cultural properties within the station's surrounding area, and confirmation from you that, absence of ground disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations and no refurbishment, there will be no anticipated impacts to tribal cultural properties within the station's environs due to continued operation of CPS.

CPS and its associated man-made cooling reservoir, Clinton Lake, are located within DeWitt County, IL. The CPS site is situated on approximately 13,626 acres in the eastern half of the county, roughly six miles east of the city of Clinton, IL and 60 miles northeast of Springfield, IL. In accordance with NRC regulations, the transmission lines within the scope of the license renewal are those located within the CPS site boundary. A figure depicting the CPS site and the vicinity within a 6-mile radius of the station is enclosed.

During the license renewal term, CEG proposes to continue operating the unit as currently operated. There are currently no ground-disturbing activities to be undertaken by CEG other than those to maintain existing structures and operations anticipated at the CPS site during the license renewal period. CEG does not anticipate any refurbishment as a result of the technical and aging management program information that will be submitted in accordance with the NRC license renewal process. Therefore, CEG does not anticipate the continued operation of CPS to adversely affect the environment or any cultural or historic resources.

As stated above, this letter seeks your input regarding tribal cultural properties within the station's surrounding area, and confirmation that there will be no anticipated impacts to tribal cultural properties within the station's environs. CEG would appreciate any comments or information you believe should be considered in the preparation of the ER.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

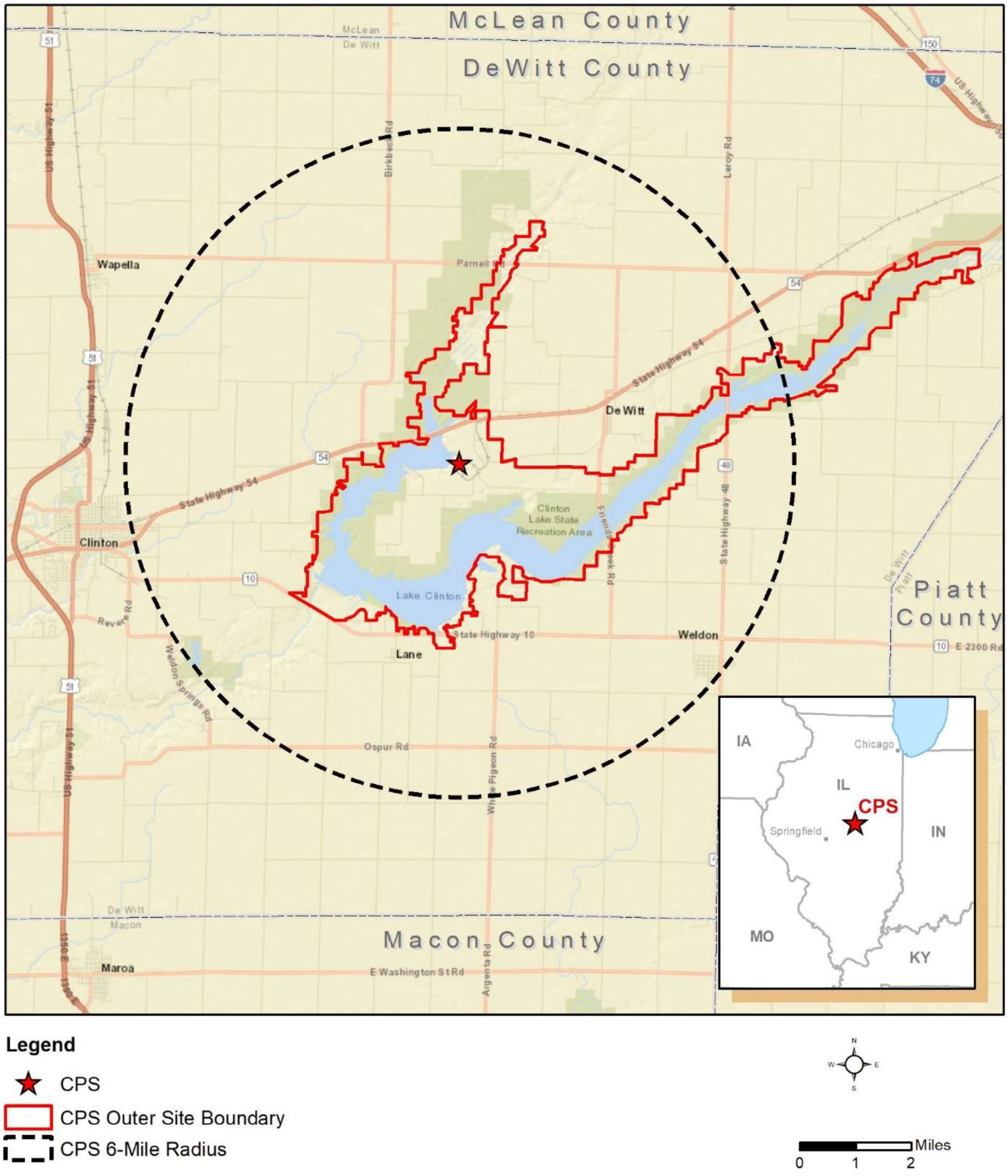
Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:44:30 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosure:
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Figure 1
Clinton Power Station Site



Illinois Department of Natural Resources

JB Pritzker, Governor • Natalie Phelps Finnie, Director
One Natural Resources Way • Springfield, Illinois 62702-1271
www.dnr.illinois.gov

DeWitt County
Clinton
8401 Power Road
CEGLLC-RS-23-010, NRC
License renewal - Clinton Power Station, Unit 1

PLEASE REFER TO: SHPO LOG #002012323

February 8, 2023

Zigmund Karpa
Exelon Nuclear
200 Exelon Way
Kennett Square, PA 19348

Dear Mr. Karpa:

We have reviewed the documentation submitted for the referenced project(s) in accordance with 36 CFR Part 800.4. Based upon the information provided, no historic properties are affected. We, therefore, have no objection to the undertaking proceeding as planned.

Please retain this letter in your files as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended. This clearance remains in effect for two (2) years from date of issuance. It does not pertain to any discovery during construction, nor is it a clearance for purposes of the Illinois Human Skeletal Remains Protection Act (20 ILCS 3440).

If you are an applicant, please submit a copy of this letter to the state or federal agency from which you obtain any permit, license, grant, or other assistance. If further assistance is needed contact Jeff Kruchten, Chief Archaeologist at 217/785-1279 or Jeffery.kruchten@illinois.gov.

Sincerely,

Carey L. Mayer

Carey L. Mayer , AIA
Deputy State Historic
Preservation Officer

Attachment E: Other Consultation Letters

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 · (217) 782-3397

JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

FEB 0 3 2023

Constellation Energy Generation, LLC
200 Exelon Way
Kennett Square, PA 19348

Subject: Clean Water Act Section 401 Determinations
RE: Clinton Power Station (CPS) Unit 1, Dewitt County and Dresden Nuclear Power Station (DNPS), Units 2 and 3.
Illinois EPA Log Nos.: C-0284-22 and C-0285-22
Bureau of Water ID#: W0398040001 (CPS) and W0638110004 (DNPS)

Sir or Madam:

On December 2, 2022, the Illinois Environmental Protection Agency (Agency) received your request for Agency determination under federal Clean Water Act (CWA) Section 401 water quality certification necessary for U.S. Nuclear Regulatory Commission (NRC) license renewal. The request concerns the prior authorizations under CWA Section 401 for the CPS Unit 1 and DNPS Units 2 and 3, issued on August 11, 1975 and October 21, 1977, respectively. The issued water quality certifications directly pertain to the Agency's authority to grant, deny or waive certification for federally issued permits or licenses authorizing the construction and or operation of facilities that may result in a discharge to waters of the U.S.

Based on the Agency's review of the CWA Section 401 water quality certifications associated with the original federal licensing process and the National Pollutant Discharge Elimination System (NPDES) permits that currently authorize wastewater and stormwater discharges from the subject facilities[1], the Agency has determined that reevaluation and certification of the subject facilities under CWA Section 401 is not necessary. The Agency has determined that NPDES permits issued for the subject facilities and pursuant to CWA Section 402 have been developed in accordance with Illinois Water Quality Standards and possess the necessary site-specific conditions ensuring that all reasonable controls and limitations have been applied to prevent or minimize pollutant loading. The Agency finds that affirmative waiver of its CWA Section 401 authority associated with the NRC licensing process for the subject facilities would eliminate duplicative efforts toward the Agency's primary goal of ensuring that regulated activities do not cause or threaten to cause water pollution as defined in the Illinois Environmental Protection Act.

Based on the above information, it is our engineering judgment that the proposed project may be completed without causing water pollution as defined in the Illinois Environmental Protection Act, provided the facilities continue to be operated in compliance with their current NPDES permits, or as modified in the future. The Agency hereby issues waiver of CWA Section 401 Water Quality Certification for the subject activity under Section 401 of the Clean Water Act (PL 95-217).

---

[1] CPS – NPDES No. IL0036919 issued March 31, 2020 and DNPS - NPDES No. IL0002224 pending renewal

This final determination does not grant immunity from any enforcement action found necessary by this Agency to meet its responsibilities in prevention, abatement, and control of water pollution.

If you have any questions about this final determination, please contact Darren Gove of my staff at either 217/782-3362 or Darren.Gove@illinois.gov.

Sincerely,

Darin E. LeCrone, P.E.
Manager, Permit Section
Division of Water Pollution Control
Illinois Environmental Protection Agency

CC: BOW_File

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

December 1, 2022
RS-22-124

Mr.Sanjay Sofat, Bureau Chief
Illinois Environmental Protection Agency, Bureau of Water
1021 North Grand Ave East
Springfield, IL 62702-4059

Subject: Application for Clean Water Act Section 401 Water Quality Certification associated with Renewal of Clinton Power Station, Unit 1 and Dresden Nuclear Power Station, Units 2 and 3 Operating Licenses

Dear Mr. Sofat:

Constellation Energy Generation, LLC (CEG) is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) and Dresden Nuclear Power Station, Units 2 and 3 (DNPS) operating licenses for an additional 20 years beyond the currently licensed terms (see Table 1 below).

Table 1: CPS and DNPS Operating License Expiration Dates

Unit	Current Operating License Expiration Date	Renewed Operating License Expiration Date
CPS Unit 1	April 17, 2027	April 17, 2047
DNPS Unit 2	December 22, 2029	December 22, 2049
DNPS Unit 3	January 12, 2031	January 12, 2051

The NRC requires that applicants for renewal of an operating license provide the NRC with a water quality certification from the State or other appropriate documentation, such as a waiver or statement that the Clean Water Act Section 401 certification does not apply. Therefore, CEG requests that the Illinois Environmental Protection Agency (IEPA) provide written confirmation that the Clean Water Act Section 401 Water Quality Certifications previously issued by the IEPA to CPS, Unit 1 and DNPS, Unit 3 remain valid for their proposed 20-year license renewal terms and that DNPS, Unit 2 does not require a certification. Supporting information is provided below.

Background

The IEPA issued a Clean Water Act Section 401 Water Quality Certification for CPS on August 11, 1975. The certification was included in Part IV Section B of NPDES Permit IL0036919 issued by the U.S. Environmental Protection Agency (USEPA) on September 30, 1975, and modified on October 21, 1977. The modified NPDES permit issued on October 21, 1977, can be viewed in Appendix B of NRC's Final Environmental Statement regarding operation of CPS found at https://www.nrc.gov/docs/ML1509/ML15098A042.pdf.

The IEPA provided a Clean Water Act Section 401 Water Quality Certification to the Atomic Energy Commission in 1973 for DNPS, Unit 3. A copy of the letter issuing the certification to Unit 3 is attached. Under the Clean Water Action Section 401(a)(6), DNPS, Unit 2 was not required to have a certification because its operating license was issued prior to April 3, 1970. The Atomic Energy Commission issued a Provisional Operating License for DNPS, Unit 2 on December 22, 1969. After gaining authorization to issue NPDES permits, IEPA issued an NPDES Permit for DNPS, Units 2 and 3 on December 30, 1976.

CPS continues to operate under NPDES Permit IL0036919, most recently renewed by IEPA on May 3, 2021. DNPS continues to operate under its administratively extended NPDES Permit No. IL0002224, issued by IEPA on September 2, 2016. CEG operates the plants in compliance with these permits and would continue to operate the plants within the limits and conditions of the permits, as well as any future applicable water quality permits and conditions. There are no new permits for a discharge to navigable waters being sought for CPS or DNPS to support or in conjunction with the plants' NRC license renewal applications.

CEG plans to include a copy of this letter and IEPA's response in the license renewal applications' Environmental Reports. Therefore, a response by January 13, 2023 is requested.

If there are any questions, please contact either Ms. Kristin Meek at 779-231-5709 or via email at kristin.meek@constellation.com or Ms. Allison Stalker at 267-533-5338 or via email at allison.stalker@constellation.com.

Respectfully,

Zigmund A. Karpa

Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2022.11.30 16:52:27 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Attachment:

Letter from W.H. Busch (IEPA Division of Water Pollution Control) to J. Scinto (Commonwealth Edison Company), Re: Dresden Generating Station Unit 3, dated March 30, 1973

cc: Darin LeCrone, P.E. - Manager, Industrial Unit, Permit Section, Bureau of Water
Illinois Emergency Management Agency – Division of Nuclear Safety (wo/attachment)
Illinois Emergency Management Agency – Clinton Representative (wo/attachment)
Illinois Emergency Management Agency – Dresden Representative (wo/attachment)

bcc: Site Vice President – Clinton Station (T. Chalmers)
Site Vice President – Dresden Station (P. Boyle)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Engineering (M. Chouinard)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Acting Regulatory Assurance Manager – Dresden Station (D. Avery II)
Environmental Lead – Clinton Station (A. Stielglitz)
Environmental Lead – Dresden Station (J. Peppmuller)
K. Meek
A. Stalker
Constellation Document Control Desk Licensing

Constellation

200 Exelon Way
Kennett Square, PA 19348
www.constellation.com

January 18, 2023
RS-23-009

Mr. Ken McCann, Chief
Division of Environmental Health
Office of Health Protection
Illinois Department of Public Health
525-535 W. Jefferson Street
Springfield, IL 62761

Subject: Constellation Energy Generation – Clinton Power Station, Unit 1 License Renewal Request for Thermophilic Organism Review

Dear Mr. McCann:

Constellation Energy Generation (CEG) is seeking a response from Illinois Department of Health (IDPH) concerning the potential existence and perceived public health risks associated with thermophilic organisms that may be present in the portion of Clinton Lake that receives the cooling water discharge from our Clinton Power Station (CPS). A figure depicting the station site and the vicinity within a 6-mile radius of the station is attached.

CEG is preparing an application with the U.S. Nuclear Regulatory Commission (NRC) for renewal of the Clinton Power Station, Unit 1 (CPS) operating license for an additional 20 years. The existing operating license will expire on April 17, 2027. The renewed license would allow CPS to operate until April 17, 2047.

As part of the license renewal process, the NRC requires that the applicant consult with the state environmental health agency regarding public health risk posed by the station's thermal discharge. Thermophilic microorganisms have the potential to be increased in number by a thermal discharge under favorable conditions and the public can be exposed to them during swimming, boating, or other recreational uses of freshwater. The thermophilic organisms that are of particular concern to the NRC include several types of bacteria (Legionella species, Salmonella species, Shigella species, and Pseudomonas aeruginosa) and the free-living amoeba Naegleria fowleri.

CPS has a thermal discharge to Clinton Lake under NPDES permit No. IL0036919. CPS withdraws water from the Clinton Lake for its circulating condenser water and raw water systems. The withdrawn water is treated with disinfectants and water treatment chemicals to prevent scaling and corrosion. After the water cools the condensers, the heated water and water from other station systems including from its sanitary wastewater treatment plant is released to a discharge flume. The water then flows back into the Clinton Lake via the discharge flume. The water can also be circulated through cooling towers installed along the discharge flume during warmer months to ensure compliance with the NPDES permit thermal limits. The NDPES permit limits the temperature of the water in the discharge flume at its entry to Clinton Lake to a daily average temperature which (1) does not exceed 99 °F (daily average) during more than 90 days in a calendar year, and (2) does not exceed 110.7 °F for any given day (daily maximum). As the discharge mixes with the lake water temperatures, temperatures attenuate; however, water temperatures during summer would be within the range for thermophilic microorganism growth.

Clinton Lake is open to the public for a variety of water sports including swimming, diving, water skiing, and boating; however, the approach to the immediate area of the thermal discharge is restricted by buoys. The lake hosts the Clinton Lake State Recreation Area which provides a beach area, campsites, multiple boat ramps, and a marina. The nearest of these to the discharge point is Weldon Day Use and Boat Access Area.

CEG's assessment in advance of any additional information from IDPH is that the continuation of CPS's thermal discharge during a 20-year extension of its license would not significantly increase the public health risk posed by the thermophilic microorganisms. The public health risk posed by the thermophilic microorganisms would remain SMALL based on (1) the low and very low incidence of human infections from thermophilic microorganisms of particular concern as related to recreational use of untreated waters and (2) that operation during the current license term is not known by CEG to have attributed to cases of waterborne disease. CEG also concludes that the microbiological hazard to the public attributable to continued operation of CPS's cooling water system's cooling towers would be SMALL because (1) the cooling towers are not accessible to the public, (2) the circulating water is treated with biocides and scale and corrosion inhibitors, and (3) the higher risk of Legionella exposure is presented by indoor or confined spaces. Assuming that IDPH does not have information that would lead to a significantly different picture of the public health risk from thermophilic microorganisms and their existence at or near CPS and Clinton Lake, CEG seeks IDPH's concurrence that the continuation of CPS's thermal discharge during a 20-year extension of its license would not significantly increase the public health risk posed by the thermophilic microorganisms.

CEG plans to include a copy of this letter and your response in the final ER that will be submitted to the NRC as part of the CPS license renewal application. Therefore, a response by March 15, 2023 is requested.

Please refer any requests regarding this submittal to Ms. Kristin Meek, CPS License Renewal Environmental Lead, at 779-231-5709 or via email at kristin.meek@constellation.com.

Respectfully,

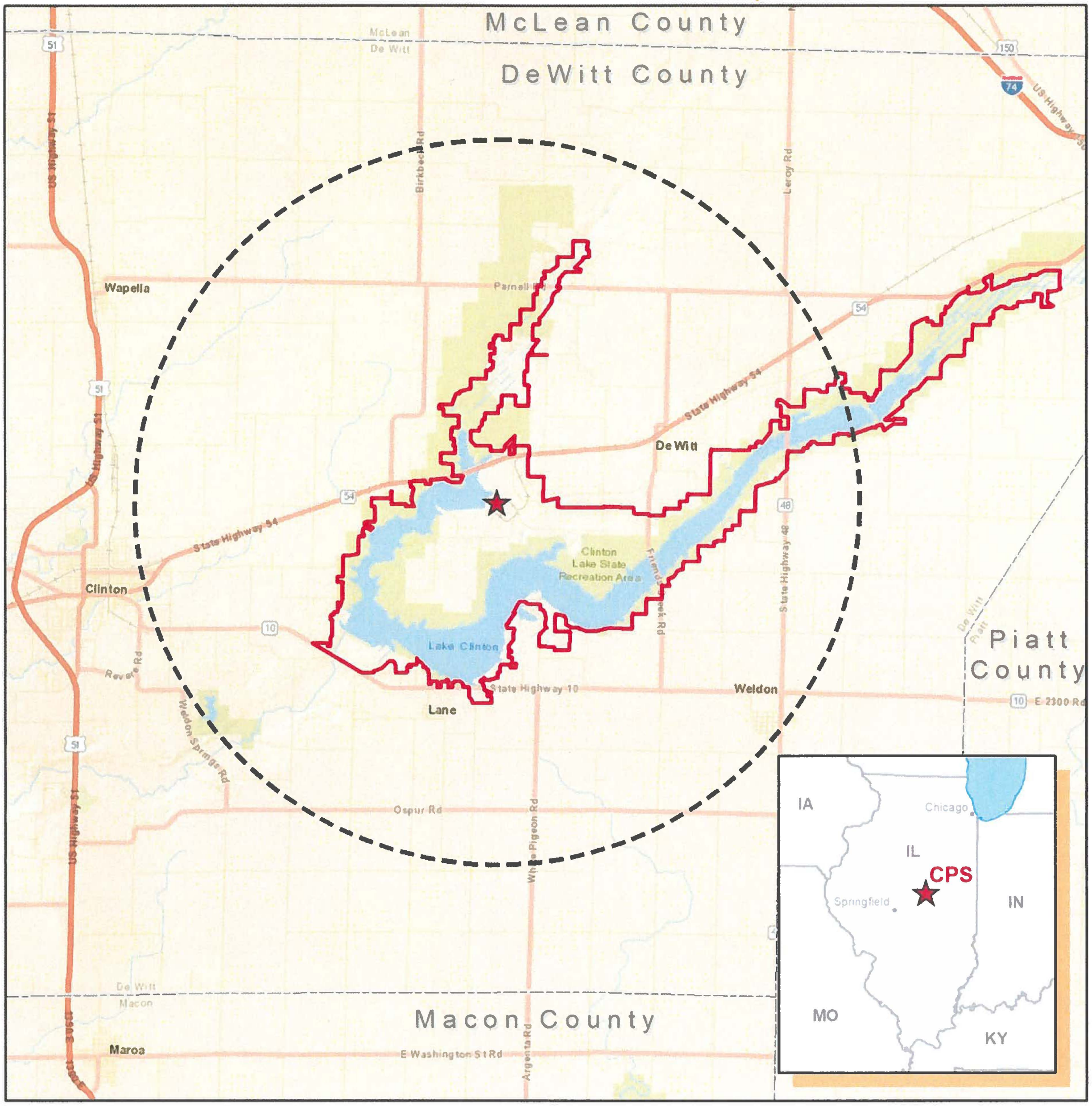
Digitally signed by Karpa, Zigmund A
DN: cn=Karpa, Zigmund A
Date: 2023.01.18 08:48:26 -05'00'

Zigmund Karpa
Director Environmental Programs and Regulatory Policy
Constellation Energy Generation, LLC

Enclosure:
Figure 1: Clinton Power Station Site

bcc: Site Vice President – Clinton Station (T. Chalmers)
Plant Manager – Clinton Station (N. Plumey)
Director Environmental Programs and Regulatory Policy (Z. Karpa)
Director Organizational Performance and Regulatory – Clinton Station (B. Currier)
Director Engineering (M. Chouinard)
Senior Manager License Renewal (C.D. Wilson)
Director - Licensing (D. Gullott)
Senior Manager Licensing (P. Simpson)
Regulatory Assurance Manager – Clinton Station (D. Livingston)
Environmental Lead – Clinton Station (A. Stielglitz)
License Renewal Environmental Lead – Clinton Station (K. Meek)
License Renewal Licensing Lead – Clinton Station (L.S. Dworakowski)
Constellation Document Control Desk Licensing

Figure 1
Clinton Power Station Site



Legend

CPS

CPS Outer Site Boundary

CPS 6-Mile Radius

Miles
0 1 2

October 19, 2023

Kristin C. Meek, P.E.
Constellation Nuclear
4300 Winfield Road
Warrenville, IL 60555

Dear Kristin:

The Illinois Department of Public Health (IDPH) received Constellation Energy Generation's (CEG) request for information concerning the public health risk posed by thermophilic microorganisms in the thermal discharge from the Clinton Power Station in Dewitt County.

IDPH maintains an electronic disease surveillance system with records as far back as 2004. Upon review of these records for Dewitt County, there have been no reported outbreaks since 2014. That includes foodborne outbreaks, non-foodborne outbreaks, and Legionnaires' Disease. Nor have there been any reported cases of primary amebic meningoencephalitis caused by Naegleria fowleri.

Cooling towers can cause outbreaks of Legionnaires' disease when they are not adequately maintained and contaminated aerosols can travel for miles. The Centers for Disease Control and Prevention (CDC) recommends that all cooling towers be operated under a water management plan in accordance with industry standards and best practices. More information is available in CDC's Toolkit for Controlling *Legionella* in Common Sources of Exposure and its Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings.

The Illinois Environmental Protection Agency (IEPA) may have additional information relevant to your request. We recommend reaching out to Todd Bennett in IEPA's Division of Water Pollution Control Field Operations Section at 217-782-8367 or todd.bennett@illinois.gov.

I hope this information is helpful. If you have any further health-related questions or concerns, please feel free to contact me at 217-785-5886 or by emailing aaron.martin@illinois.gov.

Sincerely,

Aaron Martin

Aaron Martin, LEHP
Division of Environmental Health

Attachment F: Severe Accident Mitigation Alternatives Analysis

Attachment F

Severe Accident Mitigation Alternatives Analysis

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Acronyms	
ADS	Automatic Depressurization System
ANS	American Nuclear Society
ASM	Application Specific Model
ASME	American Society of Mechanical Engineers
ATD	Atmospheric Transport and Dispersion
ATWS	Anticipated Transient Without Scram
BOC	Break Outside Containment
BOP	Balance of Plant
BWR	Boiling Water Reactor
CCDP	Conditional Core Damage Probability
CCF	Common Cause Failure
CDF	Core Damage Frequency
CET	Containment Event Tree
CFAST	Consolidated Model of Fire and Smoke Transport
CLERP	Conditional Large Early Release Probability
CPI	Consumer Price Index
CPS	Clinton Power Station
CRD	Control Rod Drive
CST	Condensate Storage Tank
DG	Diesel Generator
DW	Drywell
EALs	Emergency Action Levels
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
ELAP	Extended Loss of AC Power
EOPs	Emergency Operating Procedures
EPRI	Electric Power Research Institute
EPZ	Emergency Planning Zone
ERAT	Emergency Reserve Auxiliary Transformer
ESW	Emergency Service Water
ETE	Evacuation Time Estimate
F&Os	Facts and Observations

Acronyms	
FP	Fire Protection
FPIE	Full Power Internal Events
FPRA	Fire Probabilistic Risk Assessment
FPS	Fire Protection System
F-V	Fussell-Vesely
FW	Feedwater
GE	General Emergency
HCTL	Heat Capacity Temperature Limit
HEAF	High Energy Arcing Fault
HEP	Human Error Probability
HFE	Human Failure Event
HGL	Hot Gas Layer
HPCS	High Pressure Core Spray
HRA	Human Reliability Analysis
HVAC	Heating Ventilating Air Conditioning
IDPH	Illinois Department of Public Health
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination – External Events
ISLOCA	Interfacing Systems Loss of Coolant Accident
JHEP	Joint Human Error Probability
LERF	Large Early Release Frequency
LOCA	Loss of Coolant Accident
LOOP	Loss of Offsite Power
LPCI	Low Pressure Coolant Injection
LPCS	Low Pressure Core Spray
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequences Code System, Version 2
MACR	Maximum Averted Cost-Risk
MCA	Multi-Compartment Analysis
MCB	Main Control Board
MCC	Motor Control Center
MCR	Main Control Room

Acronyms	
MCRAB	Main Control Room Abandonment
MOR	Model of Record
MSIV	Main Steam Isolation Valve
NEI	Nuclear Energy Institute
NPSH	Net Positive Suction Head
NRC	U.S. Nuclear Regulatory Commission
OECR	Off-site Economic Cost Risk
OSP	Off Site Power
PAU	Physical Analysis Unit
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
RAT	Reserve Auxiliary Transformer
RAW	Risk Achievement Worth
RCIC	Reactor Core Isolation Cooling
RDR	Real Discount Rate
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RLE	Review Level Earthquake
RM	Risk Management
RPV	Reactor Pressure Vessel
RRW	Risk Reduction Worth
RSDP	Remote Shutdown Panel
RWCU	Reactor Water Cleanup
SAG	Severe Accident Guidelines
SAMA	Severe Accident Mitigation Alternative
SLC	Standby Liquid Control
SBO	Station Blackout
SOARCA	State-of-the-Art Reactor Consequence Analysis
SORV	Stuck Open Relief Valve
SRV	Safety Relief Valve
SP	Suppression Pool
SPC	Suppression Pool Cooling

Acronyms	
SR	Supporting Requirement
SRV	Safety Relief Valve
SSC	Systems, Structures, Components
SW or WS	Service Water
TGO	Turbine Generator Oil
UNL	Unknown Location
WINMACCS	Windows Based MACCS
WS	Water System
ZOI	Zone of Influence

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SEVERE ACCIDENT MITIGATION ALTERNATIVES

The severe accident mitigation alternatives (SAMA) analysis summarized in Section 4.15 of this Environmental Report is presented below.

F.1 METHODOLOGY

The methodology selected for this analysis is contained in NEI 05-01, Rev. A, Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document (NEI 2005), which has been reviewed and endorsed by the U.S. Nuclear Regulatory Commission (NRC). It involves identifying SAMA candidates that have the potential to reduce plant risk (frequency and/or consequences of a severe accident) and evaluating whether the implementation of those candidates is potentially beneficial on a cost-risk reduction basis. The metrics chosen to represent plant risk include the core damage frequency (CDF), the dose-risk, and the offsite economic cost-risk. Those metrics provide a measure of both the likelihood and consequences of a core damage event.

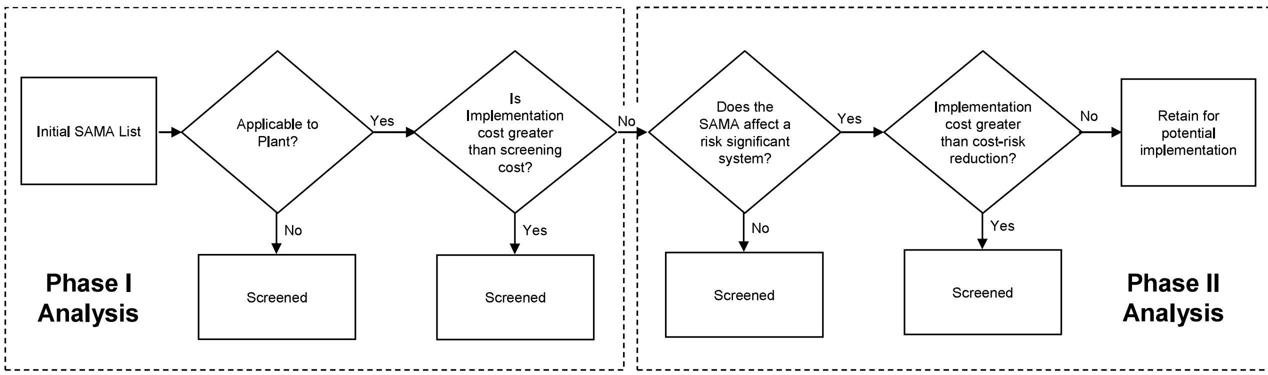
The SAMA process consists of the following principal steps:

- Clinton Power Station (CPS) Probabilistic Risk Assessment (PRA) Model – Use the CPS Internal Events PRA model as the basis for the analysis (Section F.2). Incorporate External Events contributions as described in Section F.4.6.2.
- Level 3 PRA Analysis – Use the CPS Level 1 and 2 Internal Events PRA output and site-specific meteorology, demographic, land use, and emergency response data as inputs to a Level 3 PRA performed using the WinMACCS code (Section F.3). Incorporate External Events contributions as described in Section F.4.6.2.
- Baseline Risk Monetization – Use NRC regulatory analysis techniques (NRC 2017) to calculate the monetary value of the CPS severe accident risk. That value represents the maximum averted cost-risk (MACR) (Section F.4).
- Phase 1 SAMA Analysis – Identify potential SAMA candidates based on the CPS Probabilistic Risk Assessment (PRA), Individual Plant Examination (IPE), Individual Plant Examination – External Events (IPEEE), and other relevant industry and NRC documentation. Screen out SAMA candidates that are not applicable to the CPS plant design or are of low benefit in boiling water reactors (BWRs) such as CPS; candidates that have already been implemented at CPS or whose benefits have been achieved at CPS using other means; and candidates whose estimated cost exceeds the maximum possible averted cost-risk (Section F.5).
- Phase 2 SAMA Analysis – Calculate the risk reduction attributable to each of the remaining SAMA candidates and compare it to the estimated cost of implementation to identify the net cost-benefit. PRA insights are also used to screen SAMA candidates in this phase (Section F.6). For example, SAMAs that only impact interfacing system loss of coolant accidents (ISLOCAs) may be

screened out if the SAMA's cost of implementation exceeds the cost-risk associated with ISLOCA scenarios.

- Sensitivity Analysis – Evaluate how changes in the SAMA analysis assumptions might affect the cost-benefit evaluation (Section F.7).
- Conclusions – Summarize results and identify conclusions (Section F.8).

The steps outlined above are described in more detail in the subsections of this attachment. The graphic below provides a high level overview of the SAMA analysis screening process.



SAMA SCREENING PROCESS

F.2 CPS PRA MODEL

The purpose of this section is to summarize the key aspects of the CPS PRA models, including their development, quantitative results, and insights from the CPS PRA 2017 full power internal events (FPIE) and Fire PRA updates. The CPS FPIE PRA model (CL117B) and the Fire PRA model (CL117BF0) are used to support the SAMA analysis (the Fire PRA model was slightly modified to better support the SAMA analysis as discussed in Addendum 1). Both models can quantify the core damage frequency (CDF) and a full range of Level 2 release categories, including the large early release frequency (LERF). However, CDF and LERF are the only risk metrics that are analyzed in detail as part of the model of record (MOR).

The Level 1 PRA quantifies the frequency of severe accidents that may compromise mitigative and preventive engineering safety features and, ultimately, cause damage to the nuclear reactor core. The primary result of a Level 1 PRA is quantification of the CDF based on initiating events analysis, scenario development, system analyses, and human-factor evaluations.

The CPS Level 1 PRA addresses internal events, including flooding, and loss of off-site power. External events such as fires, seismic, tornadoes and external flooding, which were analyzed separately in response to NRC Generic Letter 88-20, Supplement 4 (NRC 1991) are also addressed separately from the internal events risk in the SAMA analysis (refer to sections F.4.6.2 and F.5.1.6).

The mitigating systems referred to in the Level 1 logic model are those which shut down the reactor, provide core cooling to prevent overheating (or, ultimately, fuel melting), or provide containment heat removal. Any support systems that are necessary for the front-line systems to be successful are also included within the Level 1 scope.

The Level 1 logic model is developed to display and provide a calculational vehicle for the critical safety functions to mitigate these initiating events and to estimate the overall core damage frequency. The basic concept of a Level 1 PRA is simple. However, the large number of initiating events, systems, components, and human interactions associated with nuclear plant operation and maintenance, make the performance of the Level 1 PRA analysis complex.

The CPS PRA model is updated periodically in accordance with internal Constellation procedures to reflect plant modifications, procedure changes, and the plant-specific failure data and maintenance unavailability for major plant components.

F.2.1 PRA UPDATE FREEZE DATE

The CL117B PRA model is an update to the 2017 Clinton PRA update (CL117A). The freeze date for plant modifications for the 2017 Clinton PRA update was December 31, 2016 and this freeze date is retained for the CL117B update.

The Emergency Operating Procedures (EOPs) and Severe Accident Guidelines (SAGs) used in this analysis are those in place as of the freeze date.

F.2.2 PRA HISTORY

The Clinton Power Station (CPS) PRA model and documentation have been regularly maintained and are periodically updated to reflect the current plant configuration and the accumulation of additional plant operating history and component failure data. The Level 1 and Level 2 CPS PRA analyses were originally developed and submitted to the NRC in September 1992 as the Clinton Power Station Individual Plant Examination (IPE) Submittal in response to NRC Generic Letter

88-20. The CPS PRA has been updated many times since the original IPE and a complete history is summarized in the CPS PRA Summary Notebook (PRA FPIE 2020).

The CL117B & CL117BF0 models, which were developed during the 2017B PRA update, were recently used in the License Amendment Request (LAR) for implementation of Risk-Informed Completion Times (RICTs) in accordance with TSTF-505, Revision 2, "Provide Risk-Informed Extended Completion Times - RITSTF Initiative 4b," (ADAMS Accession No. ML18183A493) and 10 CFR 50.69, “Risk-informed categorization and treatment of structures, systems, and components for nuclear power reactors”.

The 2017B PRA update was performed to address Findings & Observations (F&Os) from the 2009 FPIE Peer Review and 2018 FPRA Peer Review and incorporated the following key changes to the 2017A models:

- Updated Residual Heat Removal (RHR) A & B Room Cooling logic to include common cause failures precluding credit for operator action for opening doors for room cooling (consistent with independent failures).
- Reduced times credited in the offsite power non-recovery probabilities to account for the time required to realign buses to offsite power sources given successful recovery of offsite power.
- Inclusion of water hammer sequences due to loss of offsite (LOOP) conditions or failure of the water leg pumps.
- Correction of the RAT-LOOP logic so that random failures of the RAT and ERAT are properly propagated through the LOOP event tree.
- Inclusion of updated HRA dependency analyses for CDF and LERF.
- Use of lower truncation limit for LERF to meet convergence criteria.
- Fire PRA Only: Modified the modeling of the Main Control Room Abandonment (MCRAB) event tree to preclude credit in specific Level 2 Containment Event Tree (CET) nodes.
- Fire PRA Only: Refined treatment of assumed routing of unknown location (UNL) components of key components to better reflect the most likely locations of those cables.
- Fire PRA Only: Identified cables susceptible to overcurrent protection concerns and updated scenario targets sets based on those susceptible cables.

F.2.3 FPIE MODEL OVERVIEW

F.2.3.1 FPIE LEVEL 1 RESULTS

The core damage frequency (CDF) model provides a tool for estimating the likelihood or frequency of core damage. Because consequences of a core damage event can range from minimal (as in the case of the Three Mile Island event in 1979) to more severe (as in the case of the Fukushima event in 2011), additional information is needed to assess risk.

The CDF for the CL117B FPIE PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-13/yr. The CL117B Level 1 CDF is 3.33E-06/yr.

Additional details related to the CL117B Level 1 model are provided in the following subsections:

- F.2.3.1.1: CDF Contribution by initiating event.
- F.2.3.1.2: CDF Contribution by accident class.

F.2.3.1.1 FPIE CDF Contribution by Initiating Event

Table F.2.3.1-1 summarizes the FPIE CDF contributors by initiating event. Figure F.2.3.1-1 presents the results as a bar chart.

Loss of offsite power (LOOP) is the dominant initiating event as they represent a major loss of mitigating events that places a high importance on the emergency diesel generators. Additionally, internal floods in the area above the Main Control Room (MCR) are significant as they can flood the control room and cause operators to abandon the MCR and use the Remote Shutdown Panel (RSDP).

F.2.3.1.2 FPIE CDF Contribution by Accident Class

Table F.2.3.1-2 summarizes the FPIE CDF contributors by accident class. Figure F.2.3.1-2 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~31% of the CDF is attributed to Class IBL, which involves a station blackout and loss of coolant inventory makeup in the “late” timeframe (> 4 hours). The next highest contributors to CDF is Class IIA (~21%; loss of containment heat removal with the reactor pressure vessel (RPV) initially intact), Class IA (~19%; loss of inventory makeup while at high pressure), and Class IBE (~16%; station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe).

F.2.3.2 FPIE LEVEL 2 RESULTS

The Level 2 PRA model is designed to identify underlying causes of containment failure for severe accidents and the associated release pathways and their frequencies. Specifically, the Level 2 PRA determines the release frequency, severity, and timing of postulated releases based on the Level 1 PRA, accident progression analysis, and containment performance.

The Level 2 PRA includes two types of analyses: (1) a deterministic analysis of the physical processes for a spectrum of severe accident progressions, and (2) a probabilistic analysis component in which the likelihood of the various outcomes is assessed. The deterministic analysis examines the response of the containment to the physical processes associated with a severe accident. Containment response is modeled by: (1) using the Modular Accident Analysis Program (MAAP) code to simulate severe accidents that have been identified as dominant contributors to core damage in the Level 1 analysis, and (2) performing reference calculations for hydrodynamic and heat transfer phenomena that occur during the progression of a severe accident.

The Level 2 PRA is based on a containment event tree (CET) model. The CET represents an accident progression given initial plant damage states and is a logic model with functional nodes that represent sequential phenomenological events and the status of containment protection systems. The CET provides the framework for evaluating containment failure modes and conditions that would affect the magnitude of the release.

The CPS CETs allow core damage scenarios defined in the Level 1 model to be further developed into consequence bins. Separating scenarios this way allows results of plant risk calculations to be presented in simple, meaningful terms. Consequence bins are based on the severity of the source term and the timing of the release relative to the time a general emergency is declared and then initiation of protective actions for the public. The characteristics of these bins are then used as input for the Level 3 model. The following subsections summarize the breakdown of the bins and the Level 2 results.

The LERF for the CL117B FPIE PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-14/yr. The CL117B Level 2 LERF is 1.65E-07/yr.

The following subsections summarize the breakdown of the bins and the Level 2 results.

- F.2.3.2.1: Consequence Bins: Source Term Severity.
- F.2.3.2.2: Consequence Bins: Timing of Release.
- F.2.3.2.3: Level 2 Radionuclide Release Categories.
- F.2.3.2.4: LERF Contribution by initiating event.
- F.2.3.2.5: LERF Contribution by accident class.

F.2.3.2.1 Consequence Bins: Source Term Severity

The radionuclide release categories are defined based on timing and severity. The severity of the radionuclide releases for purposes of binning sequences is characterized in terms of the radionuclide release fraction for CsI, which is a dominant contributor to both prompt and latent health effects. The CsI release fraction also correlates well with other contributors to offsite effects. For consequence calculations, additional radionuclides are included as inputs to the release. The bins used to define the release magnitude spectrum are as follows and each CET sequence endstate is assigned a release category.

Characterization	Designator	CsI Release Fraction
High	H	> 10%
Medium	M	> 1% and ≤ 10%
Low	L	> 0.1% and ≤ 1%
Low-Low	LL	≤ 0.1%

F.2.3.2.2 Consequence Bins: Timing of Release

Each sequence that leads to a radioactive release from containment is classified as "early", "intermediate", or "late". This designation is intended to reflect mitigation of consequences by evacuating people from the area, as appropriate. The "early" classification is used for scenarios in which a radioactive release occurs before the evacuation of the 10-mile Emergency Planning Zone (EPZ) is assumed to be complete. Based on the Evacuation Time Estimate (ETE) study (Exelon 2010), the worst-case conditions (weather, etc.) correlate to a 10-mile EPZ evacuation time of 4 hours from the point when a general emergency (GE) is declared. The "Early" scenarios, therefore, are those scenarios in which a radioactive release occurs within 4 hours of the time that a GE is declared. Releases occurring beyond 4 hours from the declaration of a GE are categorized as "late" (the "intermediate" classification is not used).

F.2.3.2.3 Level 2 Radionuclide Release Categories

The Level 2 containment event tree end states are delineated by the magnitude and timing of the calculated radionuclide release. Using the end state release magnitude and timing, a comparison can be developed to identify the overall frequency of the various end state release magnitudes (from very low (i.e., low-low) to high) and release timings (from early to late).

The frequency of radionuclide release is characterized by the quantification of the Level 1 and Level 2 PRA models. The Level 2 radioactive release frequency event tree end states are delineated by the magnitude and timing bins of the calculated radionuclide release (e.g., H/E corresponds to “high” magnitude and “early” timeframe).

Table F.2.3.2-1 provides a frequency matrix of the radionuclide release categories and the Level 1 accident classes. Figure F.2.3.2-1 presents the results as several bar charts.

A fraction (approximately 29%) of the core damage accidents transferred from Level 1 PRA are effectively mitigated, such that releases are essentially contained within an intact containment (i.e., INTACT release bin). In addition, only about 5% of the postulated accidents lead to “large early” release (i.e., approximately 5% of the accidents result in LERF).

F.2.3.2.4 FPIE LERF Contribution by Initiating Event

Table F.2.3.2-2 summarizes the FPIE LERF contributors by initiating event. Figure F.2.3.2-2 presents the results as a bar chart.

Loss of offsite power (LOOP) is the dominant initiating event as they represent a major loss of mitigating events that places a high importance on the emergency diesel generators. Additionally, internal floods in the area above the Main Control Room (MCR) are significant as they can flood the control room and cause operators to abandon the MCR and use the Remote Shutdown Panel (RSDP).

F.2.3.2.5 FPIE LERF Contribution by Accident Class

Table F.2.3.2-3 summarizes the FPIE LERF contributors by accident class. Figure F.2.3.2-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~43% of the LERF is attributed to Class IBE, which involves a station blackout and loss of coolant inventory makeup in the “early” timeframe (< 4 hours). The next highest contributors to LERF are Class IV (~20%; failure of adequate shutdown reactivity), and Class IIA (~8%; loss of containment heat removal with the RPV initially intact).

F.2.3.3 SYSTEM IMPORTANCE MEASURES

The CPS PRA utilizes three industry standard risk importance measures to put the importance of components, trains, functions, initiating events (IE), Human Error Probabilities (HEPs), etc. into perspective:

- Fussell-Vesely (F-V) is the fractional contribution of the specific element in question (component, train, system, function, IE, or HEP) to the total risk. The F-V importance calculation is generally in the form of a fractional number that may be directly translated into a percentage contribution to risk. For example, 0.0230 or 2.3E-02 may be directly translated into a 2.3% contribution to risk.
- Risk Achievement Worth (RAW) is the factor by which the risk would increase if the specific element in question (component, train, system, function, IE, or HEP) is assumed to fail. For example, if a component, train, system, function or HEP has a RAW of 2.0, the calculated risk would double if the event were assumed to have a failure probability of 1.0.
- Risk Reduction Worth (RRW) is the factor by which the risk would decrease if the component, train, system, function, IE, or HEP is assumed to be perfectly reliable (i.e., if its probability of failure were zero).

Risk importance measures reflect the degree of contribution that a system or train's failure has to the current assessment of risk (Fussell-Vesely) or how greatly risk would be increased by the guaranteed failure of a train or system (RAW). These importance measures can be different for the different trains of a system or different among seemingly similar systems. Such asymmetries reflect the fact that system and train importance determinations for the CPS risk profile are affected by a number of factors. The three principal factors are:

- Plant design features that create higher importance for certain systems and trains.
- Masking of system or train importance by other failures.
- Modeling asymmetries (including pumps assumed normally operating).

Figure F.2.3.3-1 shows the relative importance of system, train, or component importance to CPS FPIE CDF using the Fussell-Vesely importance measure.

Figure F.2.3.3-2 shows the relative importance of system, train, or component importance to CPS FPIE LERF using the Fussell-Vesely importance measure.

F.2.3.4 SUMMARY OF THE IMPACT OF ASYMMETRIES ON RISK

The principal plant design feature asymmetries impacting the CPS risk profile are:

- AC and DC Divisions 1, 2, and 3 support substantially different equipment.
- Reactor core isolation cooling (RCIC), RHR ‘A’ and low pressure core spray (LPCS) are on Division 1
- RHR ‘B’ and RHR ‘C’ are on Division 2
- Division 3 provides coolant injection (High Pressure Core Spray (HPCS) but does not provide a containment heat removal function
- RHR ‘C’ is a low pressure coolant injection (LPCI)-only train (i.e., no suppression pool cooling or other decay heat removal capability). As such, RHR ‘C’ is less risk significant than RHR ‘A’ and RHR ‘B’ (which are capable of LPCI, SDC, suppression pool cooling and containment sprays).
- Containment venting paths modeled in the PRA will fail if Division 1 power is not available.
- SX Division 3 does not require room cooling for the 24 hour mission time, but SX Divisions 1 and 2 do require room cooling for the 24 hour mission time.
- Service water (WS) pumps A and C are powered by 4kV Balance of Plant (BOP) Bus 1A and WS pump B is powered by 4kV BOP Bus 1B.

F.2.4 FIRE MODEL OVERVIEW

F.2.4.1 FIRE LEVEL 1 RESULTS

The Fire CDF for the CL117BF0 Fire PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-11/yr. The CL117BF0 Level 1 Fire CDF is 7.75E-05/yr.

Additional details related to the CL117BF0 Level 1 model are provided in the following subsections:

- F.2.4.1.1: Fire CDF Contribution by physical analysis unit (PAU).
- F.2.4.1.2: Fire CDF Contribution by fire scenario.
- F.2.4.1.3: Fire CDF Contribution by accident class.

F.2.4.1.1 Fire CDF Contribution by PAU

Table F.2.4.1-1 summarizes the Fire CDF contributors by PAU (i.e., fire zones). Figure F.2.4.1-1 presents the results as a bar chart. Only PAUs with more than 1% contribution to the total Fire CDF are explicitly included in the table, otherwise, they are grouped together in the “Other” category.

CB-6a (Main Control Room)

The Main Control Room contributes a Fire CDF of 1.73E-05/yr (~22%) and a Fire LERF of 5.78E-07/yr (~11%). This PAU is located on Elevation 800’-0” of the Control Building and contains all of the Main Control Boards (MCBs) and panels used by operators to control all plant functions. The top fire scenarios in the Main Control Room are related to fires that fail all Emergency Core Cooling System (ECCS) controls and control is switched over to the Remote Shutdown Panel (RSDP). This PAU is given special consideration for detection and suppression systems to credit continuous operator presence. Several fire scenarios were postulated for applicable ignition sources in this PAU, including:

- Green - Ignition Source Only
- Yellow - Target Damage within a Analyzed ZOI (including MCBs)
- Orange - Target Damage beyond ZOI, prior to Hot Gas Layer (HGL) that leads to MCR Abandonment due to loss of control/function
- Red - HGL Formation that leads to MCR Abandonment due to inhospitable room conditions
- Magenta - Multi-Compartment Analysis (MCA)

A-2k (Nonsafety Switchgear Room, East)

The Nonsafety Switchgear Room (East) contributes a Fire CDF of 1.07E-05/yr (~14%) and a Fire LERF of 6.12E-07/yr (~12%). This PAU is located on Elevation 762’-0” of the Auxiliary Building, directly below the Division 1 Switchgear Room (PAU A-2n) and contains equipment and cables associated with critical equipment modeled in the Fire PRA. Typical system-level failures in the PAU are RCIC, LPCS, RHR (Division 1), SX (Division 1), Division 1 AC and DC power, RAT & ERAT, Emergency Diesel Generators (EDGs) (Division 1), Containment Venting, and BOP (e.g., Instrument Air, Control Rod Drive (CRD), Feedwater (FW)). This PAU contains several automatic ionization fire detectors, but no automatic suppression system. Several fire scenarios were postulated for applicable ignition sources in this PAU, including:

- Green - Ignition Source Only
- Yellow - Target Damage within a Analyzed ZOI
- Orange - Target Damage beyond ZOI, prior to Hot Gas Layer (HGL)
- Red - HGL Formation (Screened out based on CFAST results)
- Magenta - Multi-Compartment Analysis (MCA) (Screened out based on CFAST results)

T-1h (TB General Access and Equipment Area)

The TB General Access and Equipment Area contributes a Fire CDF of 9.12E-06/yr (~12%) and a Fire LERF of 6.27E-07/yr (~12%). This PAU is located on Elevations 762'-0" and 785'-0" of the Turbine Building, directly adjacent to the Non-Safety Switchgear Rooms (A-2k & A-3d) in the Auxiliary Building. Typical system-level failures in the PAU are offsite power and BOP, but due to cables with inadequate overcurrent protection, fire-induced failure of these cables will fail all cables co-located with the unprotected cables, back to the upstream DC power source. As a result of the additional targets, the main 201 / 221 RAT and ERAT circuit breakers fail to open, thus preventing the diesel generators from loading onto the 4.16kVAC buses. This PAU contains various fire detection and suppression systems to limit the potential spread of oil from the hydrogen seal oil unit or motor-driven reactor feedwater pump. Several fire scenarios were postulated for applicable ignition sources in this PAU, including:

- Green - Ignition Source Only
- Yellow - Target Damage within a Analyzed ZOI
- Orange - Target Damage beyond ZOI, prior to Hot Gas Layer (HGL)
- Red - HGL Formation
- White - Undeveloped full room burnout scenarios

A-2n (Division 1 Switchgear Room)

The Division 1 Switchgear Room contributes a Fire CDF of 8.98E-06/yr (~12%) and a Fire LERF of 5.55E-07/yr (~10%). This PAU is located on Elevation 781'-0" of the Auxiliary Building and contains equipment and cables associated with critical power equipment modeled in the Fire PRA. Typical system-level failures in the PAU are HPCS, RCIC, LPCS, RHR (Division 1), SX (Division 1), Division 1 AC and DC power, RAT & ERAT, EDGs (Divisions 1 and 3), Containment Venting, and BOP (e.g., Instrument Air, CRD, FW). The Remote Shutdown Panel (RSDP) is also located in this PAU. This PAU contains several automatic ionization fire detectors, but no automatic suppression system. Several fire scenarios were postulated for applicable ignition sources in this PAU, including:

- Green - Ignition Source Only
- Yellow - Target Damage within a Analyzed ZOI
- Orange - Target Damage beyond ZOI, prior to Hot Gas Layer (HGL)
- Red - HGL Formation (Screened out based on CFAST results)
- Magenta - Multi-Compartment Analysis (MCA) (Screened out based on CFAST results)

F.2.4.1.2 Fire CDF Contribution by Scenario

Table F.2.4.1-2 summarizes the Fire CDF contributors by fire scenario. Figure F.2.4.1-2 presents the results as a bar chart. Only fire scenarios with more than 1% contribution to the total Fire CDF are explicitly included in the table, otherwise, they are grouped together in the "Other" category.

%F_T-1H_1TO02S_O_W

This scenario represents an undeveloped oil fire from the Turbine Generator Oil (TGO) unit in the Turbine Building (PAU T-1h). This scenario contributes a Fire CDF of 6.15E-06 (~8%) and a Fire LERF of 4.30E-07/yr (~8%), making it the most risk-significant fire scenario to Fire CDF and Fire LERF. As previously discussed in Section 4.3, PAU T-1h contains cables with inadequate overcurrent protection such that fire-induced failure of the cables will fail all cables co-located with the unprotected cables, back to the upstream DC power source. As a result of the additional targets, the main 201 / 221 RAT and ERAT circuit breakers fail to open, thus preventing the diesel generators from loading onto the 4.16kVAC buses.

Detailed fire modeling was not performed for this ignition source but given the large amount of oil (680 gallons) and the proximity of the unprotected cables (specifically cables 1TO13D & 1TO15C), a fire at this source would likely impact the unprotected cables, thus causing the cascading impacts. Detailed fire modeling could reduce the risk significance of this scenario, but to completely eliminate the risk-significance of this scenario, a plant modification would be required to install proper overcurrent protection.

%F_A-2K_1AP06E_H_O

This scenario represents a High Energy Arcing Fault (HEAF) fire at 4.16kV MVSG 1AP06E that grows beyond the specified Zone of Influence (ZOI), but does not create a Hot Gas Layer. For the Clinton Fire PRA, the target set for an “Orange” scenario is assumed to be a full room burnout because the fire beyond the ZOI is considered “unanalyzed” by the Fire Modeling Workbook. This scenario contributes a Fire CDF of 1.67E-06/yr (~2%) and a Fire LERF of 1.02E-07/yr (~2%), making it the second most risk- significant fire scenario to Fire CDF. Associated system-level failures include RCIC, LPCS, RHR (Division 1), Division 1 AC & DC power, RAT & ERAT, and BOP (e.g., Instrument Air and CRD).

Fire Modeling was developed for this ignition source; however, its risk significance is primarily due to a relatively high CCDP (~0.06), which is identical to the CCDP of the “Yellow” (ZOI) fire scenario for this ignition source. Further refinements to the fire modeling could reduce the risk significance of this scenario (e.g., breaking up the ZOI scenarios).

%F_CB-6A_1H13-P744_E_Y

This scenario represents an electrical fire at Main Control Room (MCR) panel 1H13-P744 that grows to a specified Zone of Influence (ZOI), damaging all components and cables within the ZOI. This scenario contributes a Fire CDF of 1.47E-06/yr (~2%) and a Fire LERF of 1.50E-07/yr (~3%), making it the third most risk-significant fire scenario to Fire CDF and Fire LERF. Associated system-level failures include HPCS, RHR (Division 2), SX (Division 2), Divisions 2 and 3 AC & DC power, RAT & ERAT, and BOP (e.g., Instrument Air and CRD).

Fire Modeling was developed for this ignition source; however, its risk significance is primarily due to a relatively high CCDP (~0.07). Further refinements to the fire modeling could reduce the risk significance of this scenario (e.g., breaking up the ZOI scenario into multiple ZOI scenarios).

%F_CB-3A_1DC17E_E_Y

This scenario represents an electrical fire at motor control center (MCC) 1DC17E that grows to a specified Zone of Influence (ZOI), damaging all components and cables within the ZOI. This scenario contributes a Fire CDF of 1.36E-06/yr (~2%) and a Fire LERF of 1.16E-07/yr (~2%), making it the fourth most risk-significant fire scenario to Fire CDF and Fire LERF. Associated system-level failures include HPCS, Division 3 AC & DC power, RAT & ERAT, and BOP (e.g., Instrument Air and CRD).

Fire Modeling was developed for this ignition source; however, its risk significance is primarily due to a relatively high CCDP (~0.05). Further refinements to the fire modeling could reduce the risk significance of this scenario (e.g., breaking up the ZOI scenario into multiple ZOI scenarios).

%F_C-2_1G36-P002_E_O

This scenario represents a control panel fire at 1G36-P002 that grows beyond a specified Zone of Influence (ZOI), conservatively damaging all components and cables within PAU C-2. This scenario contributes a Fire CDF of 3.63E-07/yr (~0.5%) and a Fire LERF of 2.37E-07/yr (~4%), making it the second most risk-significant fire scenario to Fire LERF. Associated system-level failures include HPCS (Auto), RCIC, LPCS, RHR (all divisions), Containment Venting, and BOP (e.g., Instrument Air, Standby Liquid Control (SLC), CRD, and FW).

Fire Modeling was developed for this ignition source; however, its risk significance is primarily due to a high CCDP and CLERP (~1.0). PAU C-2 (Containment) contains equipment and cables associated with all divisions of safety-related systems, so assuming the control panel will fail everything on all elevations beyond the specified ZOI is conservative. Further refinements to the fire modeling would reduce the risk significance of this scenario (e.g., creating additional “Yellow – ZOI” scenarios such that the “Orange – Beyond ZOI” contribution is reduced).

F.2.4.1.3 Fire CDF Contribution by Accident Class

Table F.2.4.1-3 summarizes the Fire CDF contributors by accident class. Figure F.2.4.1-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~32% of the Fire CDF is attributed to Class IIA, which involves a loss of containment heat removal with the RPV initially intact. This large contribution is due to a significant fraction of fires failing RHR suppression pool cooling (SPC) and containment venting. The next highest contributor to Fire CDF is Class IBE (station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe), with a ~24% contribution. The significance of Class IBE is expected because Clinton’s offsite power cables and bus duct run together in several areas of the plant. The final significant contributors are Class IBL with a ~16% contribution and Class IA with a ~16% contribution. Class IBL sequences involve a station blackout and loss of coolant inventory makeup in the “late” timeframe (> 4 hours) and Class IA sequences involve loss of inventory makeup while at high pressure. The remaining classes contribute a relatively small or zero (represented by a “-“) contribution to Fire CDF.

F.2.4.2 FIRE LEVEL 2 RESULTS

The Fire LERF for the CL117BF0 Fire PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-12/yr. The CL117BF0 Level 2 Fire LERF is 5.30E-06/yr.

Additional details related to the CL117BF0 Level 2 model are provided in the following subsections:

- F.2.4.1.1: Fire LERF Contribution by physical analysis unit (PAU).
- F.2.4.1.2: Fire LERF Contribution by fire scenario.
- F.2.4.1.3: Fire LERF Contribution by accident class.

F.2.4.2.1 Fire LERF Contribution by PAU

Table F.2.4.2-1 summarizes the Fire LERF contributors by PAU (i.e., fire zones). Figure F.2.4.2-1 presents the results as a bar chart. Only PAUs with more than 1% contribution to the total Fire LERF are explicitly included in the table, otherwise, they are grouped together in the “Other” category. See Section F.2.4.1.1 for a discussion of the top contributing PAUs.

F.2.4.2.2 Fire LERF Contribution by Scenario

Table F.2.4.2-1 summarizes the Fire LERF contributors by fire scenario. Figure F.2.4.2-1 presents the results as a bar chart. Only fire scenarios with more than 1% contribution to the total Fire LERF are explicitly included in the table, otherwise, they are grouped together in the “Other” category. See Section F.2.4.1.2 for a discussion of the top contributing fire scenarios.

F.2.4.2.3 Fire CDF Contribution by Accident Class

Table F.2.4.2-3 summarizes the Fire LERF contributors by accident class. Figure F.2.4.2-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~53% of the Fire LERF is attributed to Class IBE sequences, which involve a station blackout leading to early core damage. This high proportion emphasizes the high dependence on offsite power and the diesel generators. The other risk significant classes are Class IIA at ~19% and Class IA at ~13%.

F.2.5 PRA QUALITY

The Clinton Full Power Internal Events (FPIE) PRA Model of Record (MOR) is CL117A; however, the FPIE PRA model was updated in 2019 to resolve several F&Os from the October 2009 Peer Review. This updated FPIE PRA model (CL117B) was signed off in February 2020 as an Application-Specific Model (ASM) and is utilized for this evaluation. The Clinton Fire PRA (FPRA) model (CL117BF0) is also an ASM, and it is based on the CL117B FPIE PRA. These updates resolved a large majority of outstanding open items, including FPIE & FPRA F&Os, such that they are no longer considered to be issues that need to be addressed in the uncertainty analysis for this evaluation.

The CPS PRA modeling is highly detailed, including a wide variety of initiating events, modeled systems, operator actions, and common cause events. The PRA model quantification process used for the CPS PRA is based on the event tree / fault tree methodology, which is a well-established methodology in the industry.

Constellation employs a multi-faceted approach to establishing and maintaining the technical adequacy and plant fidelity of the PRA models for all operating Constellation nuclear generation sites. This approach includes both a proceduralized PRA maintenance and update process, and the use of self-assessments and independent peer reviews. The following information describes this approach as it applies to the CPS PRA.

F.2.5.1 PRA MAINTENANCE AND UPDATE

The Constellation Risk Management process ensures that the applicable PRA model remains an accurate reflection of the as-built and as-operated plants. This process is defined in the Risk Management program, which consists of a governing procedure (ER-AA-600, "Risk Management") and subordinate implementation guidelines. The overall Risk Management program defines the process for implementing regularly scheduled and interim PRA model updates, for tracking issues identified as potentially affecting the PRA models (e.g., due to changes in the plant, errors or limitations identified in the model, industry operating experience), and for controlling the model and associated computer files. To ensure that the current PRA model remains an accurate reflection of the as-built, as-operated plants, the following activities are routinely performed:

- Design changes and procedure changes are reviewed for their impact on the PRA model.
- New engineering calculations and revisions to existing calculations are reviewed for their impact on the PRA model.
- Maintenance unavailabilities are captured, and their impact on CDF is trended.
- Plant-specific initiating event frequencies, failure rates, and maintenance unavailabilities are updated approximately every four years.

In addition to these activities, the Risk Management procedures provide the guidance for particular risk management and PRA quality and maintenance activities. This guidance includes:

- Documentation of the PRA model, PRA products, and bases documents.
- The approach for controlling electronic storage of Risk Management (RM) products, including PRA update information, PRA models, and PRA applications.
- Guidelines for updating the full-power, internal events PRA models for Constellation nuclear generation sites.
- Guidance for use of quantitative and qualitative risk models in support of the On-Line Work Control Process Program for risk evaluations for maintenance tasks (corrective maintenance, preventive maintenance, minor maintenance, surveillance tests and modifications) on systems, structures, and components (SSCs) within the scope of the Maintenance Rule (10 CFR 50.65(a)(4)).

In accordance with this guidance, regularly scheduled PRA model updates nominally occur on an approximately four-year cycle; shorter intervals may be required if plant changes, procedure enhancements, or model changes result in significant risk metric changes. In addition, Constellation now maintains a continuous updated model to ensure the risk assessment of the as-built, as-operated plant does not deviate significantly from the model of record.

F.2.5.2 APPLICABILITY OF PEER REVIEW FINDINGS AND OBSERVATIONS

The CPS PRA model for internal events received a formal industry peer review in October 2009. The CPS Full Power Internal Events (FPIE) (including internal flooding) Peer Review was performed using the NEI 05-04 process, the ASME/ANS PRA Standard (ASME/ANS RA-Sa-2009) and Regulatory Guide 1.200, Rev. 2. The Peer Review found that 78.5% of the SRs evaluated met Capability Category II or better. There were fifty-six (56) SRs that were assessed as "Not Met" and twelve (12) SRs that were assessed as meeting only Capability Category I. Of the 68 SRs which were assessed as not meeting Capability Category II or better, seven (7) were related to Internal Flooding SRs. Several of the F&Os associated with the open SRs were related to documentation issues.

The 2009 FPIE Peer Review F&Os were addressed during several periodic PRA updates and the resolutions to the F&Os were reviewed by independent review teams in two separate F&O Closures (in December 2018 and November 2019) that included FPIE & Fire PRA F&Os. The independent review teams concluded that for the FPIE PRA, one F&O was dispositioned as "partially resolved" and one F&O was dispositioned as "open". All other F&Os representing a gap to meeting CC II for all SRs were dispositioned as "resolved".

The FPIE PRA Peer Review identified FPIE F&Os associated with SRs assessed as less than CC II. Table F.2.5-1 summarizes those F&Os that remain "open" (including those that may be only "partially resolved") at the time of this report. The F&Os discussed in this table represent the gaps to meeting Capability Category II for the FPIE PRA model.

As documented in Table F.2.5-1, only two FPIE F&Os remain open. An assessment with respect to the impact on this application is also provided for each open F&O.

Based on the assessments provided in Table F.2.5-1, it is concluded that the CPS Internal Events PRA (including internal flooding) is of adequate technical capability to support the SAMA analysis.

The CPS Fire PRA (FPRA) Peer Review was performed in April 2018 using the NEI 07-12 Fire PRA peer review process, the ASME/ANS PRA Standard (ASME/ANS RA-Sa-2009) and Regulatory Guide 1.200, Revision 2. The purpose of this review was to establish the technical adequacy of the FPRA for the spectrum of potential risk-informed plant licensing applications for which the FPRA may be used.

The 2018 CPS FPRA Peer Review was a full-scope review of the CPS at-power FPRA against all technical elements in Part 4 of the ASME/ANS PRA Standard, including the referenced internal events Supporting Requirements (SRs). The Peer Review found that 96.9% of the SRs evaluated met Capability Category (CC) II or better. There were five (5) SRs that were assessed as "Not Met" and eight (8) SRs that were assessed as meeting only CC I. Many of the F&Os, leading to open SRs, were related to documentation issues.

The 2018 FPRA Peer Review F&Os were addressed in subsequent FPRA updates and the resolutions to the F&Os were reviewed by independent review teams in two separate F&O

Closures (in December 2018 and November 2019) that included FPIE & FPRA F&Os. The independent review teams concluded that for the FPRA, all F&Os have been dispositioned as "resolved". Therefore, there are no open F&Os to discuss for this application.

The model changes required to close each of the F&Os and finalize model CL117B/CL117BF0 were defined as “PRA maintenance” tasks; no “model upgrades” were required.

Given the resolution of all F&Os related to SRs assessed with less than a CC II, it is concluded that the CPS FPRA is of adequate technical capability to support the SAMA analysis.

F.2.5.3 PRA QUALITY SUMMARY

The CPS PRA maintenance and update processes and technical capability evaluations described above provide a robust basis for concluding that the PRA is suitable for use in this risk-informed application.

F.3 LEVEL 3 RISK ANALYSIS

The Level PRA 3 combines the Level 2 PRA results with site-specific parameters (e.g., population distribution, meteorological data, land use data, and economic data) to estimate offsite public dose and offsite economic consequences of the postulated releases to the environment. This section addresses the key input parameters and analysis of the Level 3 portion of the risk assessment. In addition, Section F.7.3 summarizes a series of sensitivity evaluations to potentially impactful input parameters and modeling assumptions.

F.3.1 OVERVIEW

The WinMACCS code (Sandia 2021), version 3.10.0, was used to perform the Level 3 PRA for CPS. WinMACCS is an updated version of the MACCS2 code (NRC 1998) which was developed to support probabilistic risk assessments and is the standard code used to calculate off-site population dose and economic costs in support of a SAMA analysis, as recognized in NEI 05-01 (NEI 2005). The atmospheric transport and dispersion (ATD) straight-line Gaussian plume segment model incorporated in WinMACCS has been compared against more sophisticated, variable trajectory ATD models, such as the three-dimensional ADAPT/LODI code, and shown to be acceptable for the purposes of typical WinMACCS code applications (NRC 2004b).

For the CPS analysis, the input parameter values used in the WinMACCS sample problem (i.e., NRC linear no-threshold (LNT) point estimate sample problem (Sandia 2021)) formed the initial bases. These inputs generally reflect NRC best practices for regulatory purposes with many of the sample problem inputs based on the NRC's State-of-the-Art Reactor Consequence Analysis (SOARCA) best practices (NRC 2014). Subsequently, NUREG/CR-7270 (NRC 2022b) was published in October 2022 providing updated bases for a variety of WinMACCS inputs, with some generally minor changes compared to those published in the NRC SOARCA best practices (NRC 2014) and the WinMACCS sample problem. Given the state of the CPS WinMACCS model development at that time, NUREG/CR-7270 was not specifically used as a bases for model inputs. One sensitivity has been included based on NUREG/CR-7270 and is presented in Addenduma 2 with other PRA related changes that have the potential to impact the SAMA analysis. Where applicable, the initial values from these sources (i.e., WinMACCS sample problem (Sandia 2021), SOARCA best practices (NRC 2014)) were replaced with updated site-specific values applicable to CPS and the surrounding region. For example, site-specific data included population distribution, evacuation speed, certain economic parameters such as property value of farm and non-farm land, and meteorological data. Standardized economic parameters from the SOARCA studies (NRC 2014) for the costs of evacuation, relocation and decontamination were escalated from the time of their formulation (2005) to reflect more recent (July 2022) costs. Plant-specific release data included release frequencies and the time-dependent distribution of nuclide releases representing ten (10) accident release categories. The behavior of the population during a release (as modeled through evacuation parameters) was based on plant and site-specific set points (i.e., declaration of a General Emergency) and evacuation time estimates (KLD 2014). These data were used in combination with site-specific meteorology to calculate risk impacts (exposure and economic) to the surrounding population within a 50 mile radius of CPS.

F.3.2 POPULATION

The population surrounding the CPS site is estimated for the year 2047 for counties with projected population growth (and year 2030 for counties with projected population declines), reflective of the end of the proposed extended license date of April 2047. Estimating the population of the SAMA analysis region entailed three major steps: (1) determining the year 2010 permanent population within a 50-mile radius of CPS; (2) accounting for the transient population in the 10-mile EPZ region; and (3) projecting the combined permanent and transient population out to the year 2030 or 2047 based on available population projection data, taking into account 2020 county census data.

The initial population distribution was based on year 2010 census data available via SecPop (NRC 2019a), the latest census data available for that code. The baseline resident year 2010 population from SecPop was determined for each of 192 grid elements of a polar coordinate grid consisting of sixteen directions (i.e., N, NNE, NE,…NNW) for each of twelve concentric distance rings with outer radii at 0.5, 1, 2, 3, 4, 5, 7, 10, 20, 30, 40 and 50 miles surrounding the site. Transient population data from the CPS Evacuation Time Estimate (ETE) study (KLD 2014) for the approximate 10-mile EPZ radial area around the site were added to the SecPop permanent population, consistent with the guidance of NEI 05-01 (NEI 2005), on a grid element basis. In addition to the ETE category of transient population (which is limited to visitors to the area such as lodging, campground, parks, marinas), employees, schools/daycares, and medical facilities populations identified in the ETE were also included in the initial year 2010 population estimate. CPS staff identified in the ETE were also conservatively added but were allocated to areas between 2.0-3.0 miles from the plant based on the assumption that those who leave will do so prior to the GE[1]. The CPS ETE did not identify any seasonal residents, and the correctional facility population associated with the Clinton jail identified in the ETE were not added in to minimize double counting given that census data includes correctional facilities. The addition of persons associated with schools, daycares, and medical facilities may be conservative given that many of these individuals are likely permanent residents in the 50-mile SAMA region and would already be included in the census data.

Based on the Illinois Department of Public Health (IDPH) population projection data (IDPH 2021), the majority of the counties in the 50-mile region are projected to have declining populations from 2010 to 2030, and in accordance with NEI 05-01 (NEI 2005) it is appropriate to use an earlier year for projections in such cases. Year 2030 was selected for CPS given it is early in the extended license period which would begin in 2027.

The 2020 census data for Illinois counties is now available from the Census Bureau (CB 2020) for comparison against the Illinois 2020 state projections (IDPH 2021) and was considered more accurate for inclusion as a baseline. The county projection data is presented in Table F.3-1. Development of growth rates was dependent upon whether the counties were growing or declining, as follows:

- For counties with IDPH projected declining population, the population was projected to year 2030 in lieu of 2047 to conservatively maximize the available impacted population. First, a new 2030 population projection was developed using the 2020 census population (CB 2020) and applying the IDPH decline rate between its projections for 2020 and 2030. The new 2030 population projection was then used with the IDPH 2010 census data to calculate a new 2010-2030 decline rate to be applied to the 2010 data. Thus, the 2010-2030 decline rate incorporates the newer data available in the 2020 census data.
- For three counties with IDPH projected increasing population (i.e., Champaign, McLean, and Woodford) the population was projected to year 2047 to conservatively maximize the impacted population. The year 2047 population for these counties was calculated by using the 2020 census population (CB 2020) and applying the IDPH decade growth rate between 2020 and 2030 two times (e.g., projecting 2020 census to 2030, projecting 2030 to 2040) and then a third time using 0.7 times the decade growth rate (projecting 2040 to 2047). The 2047 population projection was then used with the 2010 census IDPH data to calculate a 2010-2047 growth rate to be applied to the 2010 data. Thus, the 2010-2047 growth rate incorporates the newer data available in the 2020 county census data.

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[1] Non-essential CPS staff would leave the site at a Site Area Emergency level. For fast moving events staff may shelter-in-place on site and/or the directed evacuation route would seek to avoid the direction of a significant release.

- One county (i.e., Sangamon) was projected by the IDPH to have a slightly declining population from 2010 to 2030, but a slightly positive growth rate from 2020 to 2030. This county was treated similar to the three counties with increasing populations given the positive growth rate between 2020 and 2030 and the population was projected to 2047 incorporating the 2020 census data like the other three growing counties. It is noted, however that the overall growth rate calculated for 2010-2047 is slightly negative given the 2010 to 2020 declines.

The final population data for WinMACCS represents the combined resident and transient population projections (consistent with NEI 05-01 guidance) for the region within approximately 10 miles of the site, and the permanent resident population only for 10 to 50 miles from the site. Transients include traditional transients (e.g., lodging, parks), employees, schools/daycares and medical facilities as identified in the CPS ETE (KLD 2014). It is noted that including transient population from 10-50 miles would be overly conservative for this analysis since transients are treated as permanent residents in the WinMACCS model (e.g., owning personal property). These additional transients, if impacted by a release, would accrue costs such as per-diem housing that would be inappropriate since these transients would return to their residences outside of the impacted area. Inclusion of transients in this wider region could also lead to double counting if the transient resides elsewhere in the 50-mile region (where counted as a permanent resident).

Individual growth rates for each grid element were estimated based on the dominant county (by land area) in the grid element (i.e., a representative county was chosen). If a grid element was composed of counties with approximately equal land areas, the county with the higher growth rate was chosen. Table F.3-2 presents the county growth rates for the period 2010 to 2030/2047 developed from projections shown in Table F.3-1.

Table F.3-3 presents the year 2010 transient population within 10 miles of the site that was added to permanent population based on data in the CPS ETE (KLD 2014). Table F.3-4 presents the year 2010 residential (permanent) population within 50 miles of the site developed by SecPop (NRC 2019a). It is noted that SecPop allocates the population based on census block data, and the allocation method used by SecPop may differ from those used by other population data processing codes such that minor differences may result.

Table F.3-5 presents the projected year 2030/2047 population distribution within 10 miles of the site, which includes the transient and permanent populations.

Table F.3-6 presents the projected year 2030/2047 population distribution within 50 miles of the site, which includes the transient portions only within the first 10 miles.

F.3.3 ECONOMIC INPUT

WinMACCS requires certain agricultural and land-based economic data (fraction of land devoted to farming, annual farm sales, fraction of farm sales resulting from dairy production, and property value of farm and non-farm land) for each of the 192 grid elements. This economic data was generated by SecPop (NRC 2019a), for each of the grid elements using the 2012 Census of Agriculture file included with SecPop (the latest available census of agriculture data file for the code). SecPop includes an economic multiplier input intended to facilitate calculations for years other than those represented by the economic data file based on an escalation factor such as the Consumer Price Index (CPI). This was performed for CPS. Based on CPI data from the Bureau of Labor Statistics (BLS 2022c), a multiplier of 1.29 was input into SecPop to escalate the 2012 economic inputs from 2012 (CPI value of 229.59) to July 2022 (CPI value of 296.276).

Average farm wealth and non-farm wealth values for the region are used by WinMACCS (variables VALWF and VALWNF) to determine whether property should be condemned or decontaminated. These average values were calculated based on land-area weighting of the SecPop generated values for each grid element, resulting in values of $26,076/hectare for farm wealth (VALWF) and $514,570/person for non-farm wealth (VALWNF) in July 2022 dollars.

WinMACCS calculates costs associated the emergency phase when evacuation is modeled and the intermediate phase when population relocations are modeled to occur. The WinMACCS variables EVACST and RELCST address daily costs for evacuated and relocated individuals for food, transportation, and housing for the emergency phase and intermediate phase, respectively. WinMACCS variable POPCST addresses moving costs, alternate housing, and lost income for people in areas which require decontamination, interdiction, or condemnation. For CPS these values are based on escalating the values used in SOARCA (NRC 2014) from 2005 dollars (CPI value of 195.3) to July 2022 (CPI value of 296.276) using a CPI-based multiplier of 1.517. The variable values are presented in Table F.3-7.

WinMACCS calculates costs associated with dose reduction decontamination activities that occur in the long term. Similar to the emergency and intermediate phase, these values are based on the values used in SOARCA (NRC 2014), with costs escalated from 2005 dollars to July 2022 using a CPI-based multiplier of 1.517. The variable values are presented in Table F.3-7.

F.3.4 FOOD, AGRICULTURE, AND WATERSHED

Food ingestion is modeled using the COMIDA2 ingestion model included with WinMACCS, consistent with the WinMACCS User Guide (Sandia 2021). The COMIDA2 model utilizes national-based food production parameters derived from the annual food consumption of an average individual. Annual dose limits trigger crop or milk disposal, as appropriate. There are three user-specified input variables. These parameters and their values are presented in Table F.3-8. Values are chosen consistent with the most recent guidance of FDA 63 FR-43402 (FDA 1998), referenced from the latest EPA-400 guidance (EPA 2017).

The watershed for spatial elements must be designated as river systems or lake systems. Per NUREG/CR-4551 (NRC 1990b) the designation of lake is only used for very large bodies of water, such as Lake Michigan, which may serve as drinking water sources. Lake Michigan is outside the 50-mile radius region. The lakes around CPS are smaller in comparison and are expected to behave like river systems. Therefore, for all the spatial elements, the watershed was designated as a river system.

The CPS WinMACCS base case results indicate that approximately 16% of the total population dose is due to ingestion dose (food and water). As discussed in Section F.7.3, SOARCA (NRC 2014) did not include ingestion doses on the basis that food and water are plentiful in the U.S. Therefore, inclusion of ingestion dose may represent a conservatism.

F.3.5 NUCLIDE RELEASE

The core inventory at the time of the accident is based on a plant-specific calculation (Exelon 2021). The core inventory represents bounding isotopic values for GNF3 fuel ranging with enrichments of 3.0, 3.5, 4.0, and 4.5 weight percent for 12.5 GWd/MTU and 39.25 GWd/MTU to bound variations for beginning-of-core and end-of-core state points. A power of 3473 MWt was assumed, which is the licensed thermal power level for CPS. The bounding values were taken for each isotope such that the WinMACCS core inventory represents a composite of the enrichments and burnups. The CPS core inventory did not include values for Co-58 and Co-60. Rather than assume zero inventory (as was done in the Peach Bottom SOARCA analysis (NRC 2013b)), values were estimated from NUREG/CR-4551 (NRC 1990b) ratioed by core thermal power. The CPS core inventory (Exelon 2021) bounds the current fuel management / burnup approach and that anticipated in the period of extended operation. Table F.3-9 summarizes the estimated CPS core inventory used in the WinMACCS analysis.

Wake effect data are based on CPS containment dimensions. The top of the containment is approximately 58.2 m above grade. The containment width is approximately 37.8 m. Plume standard deviations sigma-y and sigma-z calculations are consistent with SOARCA (NRC 2014) using the MELCOR Accident Consequences Code System, Version 2 (MACCS2) User's Guide formulas (NRC 1998).

CPS nuclide radioisotope groups, as represented using the MAAP computer code version 4.0.5, are related to the WinMACCS radioisotope groups as shown in Table F.3-10. MAAP is a computer code used to predict source terms resulting from severe accidents. Nine (9) different source-term categories were developed in the CPS Level 2 PRA, shown in Table F.3-11. These release categories represent a radionuclide release severity and timing classification as shown in Table F.3-12. A separate release category for a break outside containment (BOC) (developed from the High-Early release category) has been included for the WinMACCS analysis since a BOC typically has higher conditional consequences but a lower associated frequency compared to the High-Early release category. The ten (10) release categories for the WinMACCS analysis shown in Table F.3-13. The frequency of each release bin is shown in Table F.3-14 including the frequencies from full power internal events (FPIE) which include contributions from internal flooding, and the fire frequencies.

For each of the ten (10) release categories, a representative MAAP case was chosen based on a review of the Level 2 model cutsets and the dominant types of scenarios that contribute to the release category. Brief descriptions of each release category, dominant Level 2 sequences, and the rationale for the representative MAAP case are provided in Table F.3-15. It should be noted that the release category reference MAAP cases in the Level 2 analysis (Exelon 2020) are used along with the Level 2 release category rules to assign an appropriate end state to the Level 2 sequence. A summary of the representative MAAP cases (i.e., key case timings) is shown in Table F.3-16.

Consistent with the NEI 05-01 guidance (NEI 2005), a plume release height of 29.1 m above grade is used to represent a release from the mid-height of the containment. Buoyant plume rise is modeled assuming a thermal plume heat content of 1 MW to 10 MW for all releases except intact containment (where zero heat content is assumed), as detailed in Table F.3-17. A value of 10 MW bounds typical values in SOARCA (NRC 2014). Assumptions associated with release height and plume heat content are considered in the sensitivity analyses, presented in Section F.7.3.

Representative MAAP cases were run until plateaus of the CsI and CsOH release fractions were achieved. Experience has shown that CsI is a primary contributor to early dose, and CsOH is a primary contributor to late dose and cleanup costs.

Multiple release duration periods (i.e., plume segments) were defined and represent the time distribution of each category's releases. A summary of the release magnitude and timing for those cases is provided in Table F.3-17.

WinMACCS can support a release distribution of particle size groups (i.e., up to ten). The WinMACCS sample problem includes 10 particle size groups and associated deposition velocities and was used for the CPS analysis. The dry deposition velocity is evaluated in the sensitivity analysis, presented in Section F.7.3.

F.3.6 EVACUATION AND SHIELDING AND PROTECTION

Reactor trip for each sequence is taken as time zero relative to the core containment response times. A General Emergency (GE) is declared when plant conditions degrade to the point where it is judged that there is a credible risk to the public. For the CPS analysis, the time of the GE declaration is estimated based on the CPS emergency action levels as assessed in the Level 2 PRA (Exelon 2020). The declaration times are presented in Table F.3-17. A minimum GE time of 30 minutes is used for release categories with core damage projected to occur in less than 30 minutes.

Evacuation modeling is based on data contained in the CPS ETE (KLD 2014) and is developed using three cohorts. The first cohort models the evacuation of the first 89% of the population using the 90% ETE times. The second cohort models the evacuation of the next 10% of the population (the evacuation tail) using the 100% ETE times. The third cohort models 1% of the population that is assumed to not evacuate (non-compliance). The 1% non-compliance assumption is more conservative than the 0.5% non-compliance assumed in the SOARCA studies (NRC 2013b, NRC 2013c, NRC 2019b).

The WinMACCS evacuation times for Cohorts 1 and 2 are for 360° radial evacuation of the full 10-mile EPZ (i.e., Region R02 in the ETE), based on weighting the ETE times accounting for season (i.e., winter vs. summer), time of the week (i.e., midweek vs. weekend), time of day (i.e., midday vs. evening), and weather conditions (i.e., good vs. adverse). One special event (i.e., annual Apple and Pork Festival) has been considered in the CPS ETE and this event is included in the weighted time estimate. An additional 15 minutes is added to the ETE evacuation times to account for processing time by offsite officials (e.g., receiving site recommendation, obtaining necessary government approvals, starting offsite alerts).

The ETE study evacuation times for R02 range from 1 hr 45 minutes (e.g., summer, midday, good weather) to 2 hrs 10 minutes (winter, midday, snow) for the 90% evacuation (Cohort 1), not including the 4 hr 0 minutes time for the festival. For the 100% evacuation (Cohort 2), the ETE times range from 3 hrs 20 minutes (for scenarios not involving snow) to 4 hrs 20 minutes (for scenarios involving snow), not including the 5 hr 50 minutes time for the festival. These ETE times include "shadow evacuation" of 20% of the residential population outside the EPZ, to a distance of 15 miles.

For WinMACCS modeling, Cohort 1 is assumed to evacuate the EPZ radially away from the site at an average speed of 4.0 m/sec (~9.0 mph), starting 57 minutes after the GE. The 57-minute delay accommodates offsite processing of the GE, notification of the public, and evacuation preparations by the public (e.g., loading vehicles, securing property). Cohort 2 is assumed to evacuate the EPZ radially away from the site at an average speed of 2.4 m/sec (~5.4 mph), starting 105 minutes after the GE. As noted previously, Cohort 3 is assumed to not evacuate. For comparison purposes it is noted that an average walking speed is approximately 3 mph.

The evacuation delay time and speed are assessed using sensitivity studies, consistent with NEI 05-01 (NEI 2005), and are presented in Section F.7.3.

An emergency phase of one week is used, with relocation times[2] of 12 hours (hot spot) and 24 hours (normal) consistent with the Peach Bottom SOARCA study (NRC 2013b) and MACCS2 User Guide (NRC 1998). Relocation dose criteria of 5 Rem and 1 Rem are used for hot spot and normal relocation, consistent with EPA-400 (EPA 2017).

Cloudshine and Groundshine shielding factors are based on NUREG/CR-4551 (1990b) for Zion, which was also located in Illinois. Other exposure factors (e.g., breathing rate, inhalation protection factor, skin protection factor) are based on SOARCA (NRC 2014).

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[2] Hot spot and normal relocation times only apply to individuals who do not evacuate (e.g., cohort 3 (non-compliance), those outside the EPZ). Other SOARCA plants evaluated other values. The Sequoyah study (NRC 19b) used larger values since that study assumed a large seismic event that could delay relocation activities. CPS uses the values traditionally used.

F.3.7 METEOROLOGY

Annual hourly meteorology CPS data sets from 2019 through 2021 were processed for use in the WinMACCS analysis. These data sets were obtained from the onsite meteorological stations. No additional offsite meteorological data were used with the exception of mixing layer height (as typically required for WinMACCS analyses).

The meteorological file used as input into the WinMACCS code consists of one (1) year of hourly recordings (8760) of accumulated precipitation. When precipitation occurs during a release, the depletion of the plume occurs more rapidly due to plume washout. The amount of plume washout is proportional to the intensity and duration of precipitation. The WinMACCS code does not differentiate between rain and snow precipitation.

Of the hourly data of interest (10-meter wind speed, 10-meter wind direction, multi-level temperatures used to calculate stability class, and precipitation), 1% or less of the data were missing for each of the three years of data. Traditionally, up to 10% of missing data is considered acceptable (NRC 2007). WinMACCS requires complete sequential hourly data for the full year, therefore missing data must be estimated. The percentages of data hours that included estimated data for missing data for years 2019, 2020, and 2021 were 0.2%, 0.3%, and 1%, respectively. Data gaps were filled in the following manner:

- For periods where the on-site data loss was less than 6 consecutive hours, interpolation was used.
- For periods where the on-site data loss was 6 or more consecutive hours, substitution was used using data from the same time of day either previous to or after the data void.

As presented later in the results section, the 2020 data set was selected for the base case based on the combination of low data voids and generally higher dose risk and cost risk results. Section F.7.3 presents the results of the meteorological sensitivity analysis. Table F.3-18 identifies the number of hours and their respective percentage of total hours (8760) of weather data which required filling for the base case year 2020 for each parameter.

The CPS WinMACCS model employs all 8760 hours of weather data rather than using a weather sequence sampling approach, exceeding that done by SOARCA (NRC 2013b, NRC 2013c, NRC 2019b). Consequently, the WinMACCS mean results (i.e., average results based on weather variability) are based on more data and are less influenced by any single weather sequence.

The WinMACCS code requires morning and afternoon mixing layer heights to be defined in the meteorological file for the four seasons of the year. The atmosphere mixing height values for CPS are based on EPA Holzworth data (EPA 1972). The seasonal values range from 330 m to 490 m in the morning hours and 690 m to 1600 m in the afternoon hours.

F.3.8 WINMACCS RESULTS

The CPS mean annual 50-mile population dose risk and offsite economic cost risk (OECR) from severe accidents due to full-power internal events, internal flooding, and internal fires calculated using WinMACCS are presented in Table F.3-19. These mean results are based on probabilistic weighting by release category, developed as the sum of the products of each source term category frequency from the Level 2 PRA and the WinMACCS calculated conditional consequence mean values associated with that source term. The mean value is the mean of the weather sequences. Discussion of results for other portions of the weather distribution (e.g., median results) are presented in Section F.7.3.

Table F.3-19 indicates that the total dose-risk is approximately 68.1 p-rem/yr. The total OECR is calculated to be about 963,000 $/yr. The largest contributor to these results is the high/late release category which accounts for approximately 64% of the dose risk and 72% of the cost risk.

F.4 BASELINE RISK MONETIZATION

This section explains how CPS calculated the monetary value of the status quo (i.e., accident consequences assuming no mitigation due to SAMA implementation). CPS also used this analysis to establish the maximum benefit that could be achieved if all on-line CPS risk were eliminated, which is referred to as the Maximum Averted Cost-Risk (MACR). Per the site PRA models (designated CL117B and CL117BF0), the internal events (including internal flooding) CDF is 3.33E-06 (at a truncation of 5E-13/yr) and the Fire CDF is 7.75E-05 (at a truncation of 5E-11/yr, though the cutsets generated for SAMA round to 7.76E-5/yr); however, use of the 5E-13/yr truncation limit for the internal event model resulted in quantification failures for several of the SAMA cases. To ensure complete model quantification could be achieved in reasonable time frames, the internal events model truncation limit was raised to 5E-12/yr for the SAMA analysis. The resulting CDF is slightly lower at 2.91E-06/yr, but the results are expected to capture the important impacts of SAMA implementation and use of the model with a 5E-12/yr truncation limit is considered appropriate for the SAMA analysis. The total FPIE and Fire CDF used to develop the MACR is, therefore, 8.05E-5/yr (2.91E-06/yr + 7.76E-05/yr = 8.05E-05/yr). Non-Fire external risk is addressed in Section F.4.6.2.

F.4.1 OFF-SITE EXPOSURE COST

The baseline annual off-site exposure risk was converted to dollars using the NRC's standard conversion factor for the monetary equivalent of unit dose of $5,200 per person-rem (NRC 2022a) updated to reflect recent economic data, and discounted to present value using the following NRC standard formula (NRC 1997):

$$W_{pha} = C \times Z_{pha}$$

Where:

W_{pha}	=	monetary value of public health accident risk after discounting
C	=	$[1-\exp(-rt_f)]/r$
t_f	=	years remaining until end of facility life = 20 years
r	=	real discount rate (RDR) (as fraction) = 0.03 per year
Z_{pha}	=	monetary value of public health (accident) risk per year before discounting ($ per year) (and in more detail, Z_{pha} = R (current year monetary equivalent of unit dose in $/person-rem) x D_{pa} (avoided dose per facility year in person-rem/facility year))

The Level 3 analysis showed an annual off-site population dose-risk (D_{pa}) of 55.56 person-rem per year.

Before applying the monetary equivalent of unit dose, it is first updated to the current year value based on recent economic data (to obtain "R"). Using 2021 data (the most recent year with complete information at the time of report development) from the U.S. Bureau of Labor Statistics (BLS) consumer price index for all urban customers (CPI-U) (BLS 2022a), the average CPI-U is calculated from first and second half data (266.236, 275.703) to be 270.97. Dividing this value by the reference CPI-U (236.736, from 2014) yields an inflation rate change of 114.46%. Using 2021 BLS data for median usual weekly earnings (MUWE) (BLS 2022b), the average MUWE is calculated from the quarterly data (989, 990, 1001, 1010) to be 997.5. Dividing this value by the reference MUWE (791, from 2014) yields a real income growth rate of 126.11%. Finally, using an income elasticity of 0.5 and baseline monetary equivalent of unit dose of $5,200, the current year monetary equivalent of unit dose (R) is calculated using the following formula (and rounded to two significant figures):

R = \$/person-rem$_{2022}$ = \$/person-rem$_{2014}$ x (inflation) x (real income growth)$^{\text{income elasticity}}$

$$R = \$5,200 \times 1.1446 \times 1.2611^{0.5} = \$6,700$$

The calculated value for C using 20 years and a 3 percent discount rate is approximately 15.04.

Therefore, calculating the discounted monetary equivalent of accident dose-risk involves multiplying the dose-risk (person-rem per year) by \$6,700 and by the C value (15.04).

The calculated off-site exposure cost is \$6,872,200.

F.4.2 OFF-SITE ECONOMIC COST RISK

The Level 3 analysis showed an annual off-site economic risk of \$963,485. Calculated values for off-site economic costs caused by severe accidents must also be discounted to present value. This is performed in the same manner as for public health risks and uses the same C value. The resulting value is \$14,490,441.

F.4.3 ON-SITE EXPOSURE COST RISK

Occupational health was evaluated using the NRC-recommended methodology that involves separately evaluating immediate and long-term doses (NRC 1997).

For immediate dose, the NRC recommends using the following equation:

Equation 1:

$$W_{IO} = R\{(FD_{IO})_S - (FD_{IO})_A\} \{[1 - \exp(-rt_f)]/r\}$$

Where:

W_{IO}	=	monetary value of accident risk avoided due to immediate doses, after discounting
R	=	monetary equivalent of unit dose (\$6,700 per person-rem)
F	=	accident frequency (events per year) (8.05E-05 (internal events + Fire CDF))
D_{IO}	=	immediate occupational dose [3,300 person-rem per accident (NRC estimate)]
$_S$	=	subscript denoting status quo (current conditions)

$_A$	=	subscript denoting after implementation of proposed action
r	=	real discount rate (0.03 per year)
t_f	=	years remaining until end of facility life (20 years).

Assuming F_A is zero, the best estimate of the immediate dose cost is:

$$W_{IO} = R\,(FD_{IO})_S\{[1 - \exp(-rt_f)]/r\}$$
$$= 6{,}700*8.05\text{E-}05*3{,}300*\{[1 - \exp(-0.03*20)]/0.03\}$$
$$= \$26{,}772$$

For long-term dose, the NRC recommends using the following equation:

Equation 2:

$$W_{LTO} = R\{(FD_{LTO})_S - (FD_{LTO})_A\}\{[1 - \exp(-rt_f)]/r\}\{[1 - \exp(-rm)]/rm\}$$

Where:

W_{LTO}	=	monetary value of accident risk avoided long-term doses, after discounting, $
D_{LTO}	=	long-term dose [20,000 person-rem per accident (NRC estimate)]
m	=	years over which long-term doses accrue (as long as 10 years)

Using values defined for immediate dose and assuming FA is zero, the best estimate of the long-term dose is:

$$W_{LTO} = R\,(FD_{LTO})_S\{[1 - \exp(-rt_f)]/r\}\{[1 - \exp(-rm)]/rm\}$$
$$= 6{,}700*8.05\text{E-}05*20{,}000*\{[1 - \exp(-0.03*20)]/0.03\}\{[1 - \exp(-0.03*10)]/0.03*10\}$$
$$= \$140{,}176$$

The total occupational exposure is then calculated by combining Equations 1 and 2 above. The total accident related on-site (occupational) exposure risk (W_O) is:

$$W_O = W_{IO} + W_{LTO} = (\$26{,}772+\$140{,}176) = \$166{,}948$$

F.4.4 ON-SITE CLEANUP AND DECONTAMINATION COST

The total undiscounted cost of a single event in constant year dollars (C_{CD}) that NRC provides for cleanup and decontamination is $1.5 billion (NRC 1997). The net present value of a single event is calculated as follows. NRC uses the following equation to integrate the net present value over the average number of remaining service years:

$$PV_{CD} = [C_{CD}/mr][1\text{-}\exp(-rm)]$$

Where:

PV_{CD}	=	net present value of a single event
C_{CD}	=	total undiscounted cost for a single accident in constant dollar years
r	=	real discount rate (0.03)
m	=	years required to return site to a pre-accident state (as long as ten years)

The resulting net present value of a single event is $1.3E+09. The NRC uses the following equation to integrate the net present value over the average number of remaining service years:

$$U_{CD} = [PV_{CD}/r][1\text{-}\exp(-rt_f)]$$

Where:

PV_{CD}	=	net present value of a single event ($1.3E+09)
r	=	real discount rate (0.03)
t_f	=	20 years (license renewal period)

The resulting net present value of cleanup integrated over the license renewal term, $1.95E+10, must be multiplied by the internal events CDF (8.05E-05) to determine the expected value of cleanup and decontamination costs. The resulting monetary equivalent is $1,569,137.

F.4.5 REPLACEMENT POWER COST

Long-term replacement power costs were determined following the methodology documented in NUREG/BR-0184 (NRC 1997). The net present value of replacement power for a single event, PV_{RP}, was determined using the following equation:

$$PV_{RP} = [\$1.2\times10^8/r] * [1 - \exp(-rt_f)]^2$$

Where:

PV_{RP}	=	net present value of replacement power for a single event, ($)
r	=	0.03
t_f	=	20 years (license renewal period)

To attain a summation of the single-event costs over the entire license renewal period, the following equation is used:

$$U_{RP} = [PV_{RP} / r] * [1 - \exp(-rt_f)]^2$$

Where:

U_{RP}	=	net present value of replacement power over life of facility ($-year)

After applying a correction factor to account for CPS's size relative to the "generic" reactor described in NUREG/BR-0184 (NRC 1997) (i.e., 1062 megawatt electric / 910 megawatt electric), the replacement power costs are determined to be 6.45E+09 ($-year). Multiplying 6.45E+09 ($-year) by the CDF (8.05E-05) results in a replacement power cost of $519,162.

F.4.6 MAXIMUM AVERTED COST-RISK

The CPS MACR is the total averted cost-risk if all internal and external events risks associated with on-line operation were eliminated. This is calculated by summing the following components:

- Maximum Internal Events and Fire Averted Cost-Risk
- Maximum Non-Fire External Events Averted Cost-Risk

The MACR is used in the Phase I analysis as a means of screening SAMAs. The following subsections provide a description of how each of these components is calculated and used together to obtain the CPS MACR.

F.4.6.1 INTERNAL EVENTS AND FIRE MAXIMUM AVERTED COST-RISK

The maximum internal events and Fire averted cost-risk is the sum of the contributors calculated in Sections F.4.1 through F.4.5:

Maximum Averted Internal Events and Fire Cost-Risk

Off-site exposure cost	$6,872,000
Off-site economic cost	$14,490,441
On-site exposure cost	$166,948

On-site cleanup cost	$1,569,137
Replacement power cost	$519,162
Total cost (per unit)	$23,617,888

This total represents the per unit monetary equivalent of the risk that could be eliminated if all risk associated with on-line internal event hazards (including internal floods) could be eliminated for CPS. The internal events MACR is rounded to next highest thousand ($23,618,000) for SAMA calculations. It should be noted that the Phase II cost benefit calculations account for the difference between the rounded MACR and the actual MACR by adding the difference to the cost-risk calculated for each SAMA configuration.

F.4.6.2 NON-FIRE EXTERNAL EVENTS MAXIMUM AVERTED COST-RISK

The maximum averted cost-risk for external events excluding Fire must be considered for the cost-benefit calculations; however, the current CPS External Hazards Assessment (Exelon 2020) applied a progressive screening approach and of the hazards considered, only seismic events required the development of a core damage frequency.

The method chosen to account for external events contributions in the SAMA analysis is to use a multiplier on the internal events results. In previous NRC-approved SAMA analyses, it has been assumed that the risk posed by external events and internal events is approximately equal. This assumption is not unreasonable unless analyses are available that provide more detailed insights into the potential contributions of these types of events. Because internal Fires and Seismic events are typically the most significant contributors and because the Fire PRA results are used directly in the CPS SAMA analysis, it was concluded that the development of a plant-specific non-fire external events multiplier was warranted.

The non-fire external events multiplier is the ratio of the total CDF (including internal and external events) to only the FPIE and Fire CDFs. The lack of detailed analyses makes it difficult to establish a meaningful CDF for some event types; however, the following assumptions were used to simplify the process:

- Hazards that were screened from consideration for the RICT and 10 CFR 50.69 applications were considered to be negligible and were not included in the calculation of the non-fire external events multiplier.
- For those hazards that were not screened out as negligible, the CDFs were considered to be non-negligible and were included in the calculation of the non-fire external events multiplier.

The seismic CDF that was developed in the CPS External Hazards Assessment was 6.4E-6/yr while all other hazards were screened from further consideration. The hazards that were screened from further consideration are as follows: aircraft impact, avalanche, biological event, coastal erosion, drought, external flooding, extreme wind or tornado (including tornado missiles), fog, forest or range fire, frost, hail, high summer temperature, high tide/lake level/river stage, hurricane, ice cover, industrial or military facility accident, landslide, lightning, low lake level or river stage, low winter temperature, meteorite or satellite, pipeline accident, release of chemicals in onsite storage, river diversion, sand or dust storm, seiche, snow, solid shrink-swell consolidation, storm surge, toxic gas, transportation accident, tsunami, turbine-generated missiles, volcanic activity, and waves.

Using the CDF values described above, the non-fire external events (EE) contributions could be summarized as follows:

CPS External Events CDF Summary (per year)	
Seismic	6.40E-06
Other	negligible
Total EE CDF	**6.40E-06**

The non-fire External Events multiplier is the ratio of the total CDF (including internal and external events) to the sum of the internal events and fire CDFs. Using the total external events of 6.40E-06 from above, the internal events CDF of 2.91E-06, the fire CDF of 7.76E-05, the non-fire External Events multiplier is:

Non-Fire EE Multiplier = (6.40E-06 + 2.91E-06 + 7.76E-05) / 8.05E-05 = 1.079

F.4.6.3 CPS MAXIMUM AVERTED COST-RISK

The total MACR can be obtained by multiplying the internal events cost-risk by the non-fire EE multiplier of 1.079:

Single Unit MACR = $23,618,000 * 1.079 = $25,483,822

Alternatively, as stated in Section F.4.6, the MACR can be represented by the internal and external events contributions:

Internal Events and Fire	=	$23,618,000
Non-fire External Events	=	$1,865,822
CPS Maximum Averted Cost-Risk	=	$25,483,822

F.5 PHASE 1 SAMA ANALYSIS

The Phase 1 SAMA analysis, as discussed in Section F.1, includes the development of the initial SAMA list and a coarse screening process. This screening process eliminated those candidates that are not applicable to the plant's design or are too expensive to be cost-beneficial even if the risk of on-line operations were completely eliminated (i.e., the implementation costs exceed the MACR). The following subsections provide additional details of the Phase 1 process.

F.5.1 SAMA IDENTIFICATION

The initial list of SAMA candidates for CPS was developed from a combination of resources. These include the following:

- CPS PRA results and PRA Group Insights
- Industry Phase 2 SAMAs (based on a review of potentially cost-effective Phase 2 SAMAs from selected plants, as documented in section F.5.1.3)
- CPS Individual Plant Examination IPE (IP 1992)
- CPS IPEEE (IP 1995)

These resources are judged to provide a list of potential plant changes that are most likely to reduce risk in a cost-effective manner for CPS.

In addition to the "Industry Phase 2 SAMA" review identified above, an industry-based SAMA list was used in a different way to aid in the development of the CPS plant-specific SAMA list. While the industry Phase 2 SAMA review cited above was used to identify potential SAMAs from specific sites that might have been overlooked in the development of the CPS SAMA list due to PRA modeling issues, a generic SAMA list was used to help identify the types of changes that could be used to address the areas of concern identified through the CPS importance list review. For example, if Instrument Air (IA) availability was determined to be an important issue for CPS, the industry list would be reviewed to determine if a plant enhancement had already been identified that would address CPS's needs. If an appropriate SAMA was found to exist, it would be used in the CPS list to address the IA issue; otherwise, a new SAMA would be developed that would meet the site's needs. This generic list was compiled as part of the development of multiple industry SAMA analyses and is available in NEI 05-01 (NEI 2005).

It should be noted that the process used to identify CPS SAMA candidates focuses on plant-specific characteristics and is intended to address only those issues important to the site rather than generic SAMAs that have been assessed multiple times by U.S. nuclear power plants. The rationale for the use of this approach, which has been applied in multiple SAMA submittals, was provided in the response to question 5.a of the responses to the Salem Generating Station RAIs (PSEG 2010).

F.5.1.1 LEVEL 1 CPS IMPORTANCE LIST AND RISK CONTRIBUTOR REVIEW

The importance list review was performed to identify the failure scenarios most important to the CPS risk profile and to develop methods to mitigate those scenarios. For each event on the importance list, the reasons for the event's importance are determined through sequence/cutset and systems analysis. Strategies to mitigate the relevant failures are developed based on accident sequence review, plant knowledge, and industry insights. For CPS, importance lists were developed and reviewed for the internal event and fire models.

The importance list itself was developed from the CPS PRA cutsets and comprises the model's basic events sorted according to their Fussell-Vesely (FV) values. The events with the largest FV values in this list are those events that would provide the greatest reduction in the CDF if the failure probability were set to zero. Because a PRA's importance list can be extensive, it is desirable to limit the review to only those contributors that could yield potentially cost-beneficial results.

One method that can be used to limit the scope of the importance list review is to correlate the FV value threshold to the lowest expected cost of implementation for a SAMA. Usually, operator action modifications in the form of procedure changes are among the least expensive enhancements that can be made at a site, so they have often been used as the representative "lowest cost SAMA". However, because the cost of performing a procedure change can vary by orders of magnitude depending on the scope of the change and the procedure that is being changed, this does not provide a clear basis for a review threshold. In addition, the use of this type of a threshold can lead to a review process that is beyond the scope of what is described in NEI 05-01 (NEI 2005).

The NEI 05-01 guidance describes the SAMA identification process in Section 5.1 as a process to "identify plant-specific SAMA candidates by reviewing dominant risk contributors (to both CDF and population dose) in the Level 1 and Level 2 Probabilistic Safety Assessment (PSA) models." Section 5.1 indicates that the definition of the dominant contributors is open to interpretation, but the guidance does not imply that the identification process should represent an exhaustive search for all plant enhancements that could be cost-beneficial. For example, some minor plant procedure changes could be very inexpensive, but the SAMA identification process should not be defined as one that requires a review all events that could yield averted cost-risks that are greater than the cost of such a procedure change.

Because there is not a universal definition for “dominant risk contributors”, an attempt has been made in this analysis to characterize “dominant contributors” and to establish a review threshold that can reasonably be considered to address them.

The ASME/ANS PRA Standard (ASME 2009) includes a definition of “significant” contributors to risk, but it is described in quantitative terms related to the percentages of risk represented, and the guidance does not provide many qualitative insights about the nature of “significant contributors”. In general, the term “dominant” suggests something that is ruling, governing, or in a commanding position, which does not appear to be consistent with a “risk significant” basic event or accident sequence. For example, a risk significant basic event is one with a Fussell-Vesely (FV) value of 0.005 or greater, which corresponds to an event that would reduce the CDF by 0.5% if it were made completely reliable. Events contributing only 0.5% to the CDF could not reasonably be described as “governing” or “ruling” the risk profile.

For the SAMA analysis, the threshold of a dominant basic event is considered to be a factor of 10 larger than for a risk significant event. Similarly, the threshold for a dominant individual accident sequence is considered to be an order of magnitude large than the value of 1% defined in the ASME/ANS PRA Standard for risk significant accident sequences. The definitions of the “dominant” basic events and accident sequences are assumed to be:

- Dominant Basic Events are those events with FV values greater than or equal to 0.05 (or Risk Reduction Worth values of about 1.05 or greater) for the relevant figure of merit (e.g., CDF).
- Dominant Individual Accident Sequences are those which contribute 10 percent or more to the relevant figure of merit (e.g., CDF).

Table F.5-1a documents the disposition of each basic event in the Level 1 internal events model with an FV value of 0.05 or greater. When the impact on non-fire external events is considered, this corresponds to an event that would reduce the cost-risk by less than $29,000 if it were made completely reliable (based on CDF and all release categories being reduced by 5%). Viewed from another perspective, a FV value of 0.05 corresponds to a CDF reduction of about 5% assuming the basic event failure probability were set to zero. For a baseline 2.91E-6 /yr CDF from internal events, this corresponds to a potential CDF reduction of about 1.5E-7/yr. Such a change in CDF is well below the widely accepted threshold in Region III of Figure 4 in Regulatory Guide 1.174 (NRC 2011) of what constitutes a “very small change” (less than 1E-6 /yr).

Similarly, for the fire model, which has a baseline CDF of 7.76E-5 /yr, this corresponds to a potential CDF reduction of about 3.9E-6 /yr and those events below this threshold are not considered to represent any “dominant” plant risk contributors. This change in CDF is well below the widely accepted threshold in Region II of Figure 4 in Regulatory Guide 1.174 (NRC 2011) of what constitutes a “small change” (less than 1E-5 /yr). Table F.5-1b documents the disposition of each basic event in the Level 1 Internal events model with an FV value of 0.05 or greater.

The remaining external events contributors, such as seismic, high winds, and “other” hazards, are addressed in section F.5.1.6.

F.5.1.2 LEVEL 2 CPS IMPORTANCE LIST REVIEW

The review of the Level 2 importance listings was performed in a manner similar to that which was performed for the Level 1 importance list. In this case, three separate Level 2 importance lists were developed. The reviews were performed on composite importance files for the following release categories:

- Internal Events and Fire
  - High-Early and High-Late (H/E, HL)
  - Medium-Early/Medium-Early (M/E, M/L)
  - Break Outside Containment (BOC (High-Early))

These groupings were developed to prevent high frequency-low consequence events (i.e., the L/E release category for internal events) from biasing the importance lists. For internal events, the release categories included in the review account for over 95 percent of the dose-risk while accounting for only about 41 percent of the Level 2 frequency. For fire, the release categories included in the review account for about 99 percent of the dose-risk while accounting for about 87 percent of the Level 2 frequency. Exclusion of the other results from the Level 2 review allows the contributors that are most important to dose-risk and cost-risk to rise to the top of the importance lists.

For the importance groups defined above, the number of “dominant” basic events (FV > 0.05) ranges from about 34 to 65 events, the exception being the BOC group for internal events, which is limited to 18. The events in these groups are considered to include the “dominant” risk contributors for CPS.

None of the remaining external events models are linked to the Level 2 model; therefore, it was not possible to perform a Level 2 importance review for the seismic or “other” external events hazards.

Tables F.5-2a, F.5-2b, and F.5-2c document the disposition of each basic event in the internal events Level 2 importance lists with FV values greater than 0.05 while Tables F.5-2d and F.5-2.e address the fire model contributors (there are only 2 tables for the fire model because there are no Break Outside Containment contributors).

F.5.1.3 INDUSTRY SAMA REVIEW

The SAMA identification process for CPS is primarily based on the PRA importance listings, the IPE, and the IPEEE. Use of these sources should identify the types of changes that would most likely be potentially cost-beneficial for CPS; however, a review of those SAMAs determined to be cost-beneficial for similar plants could capture potentially important changes not identified for CPS due to PRA modeling differences or because an alternate approach was developed to mitigate a similar risk. Therefore, in addition to the plant-specific review, selected industry SAMA submittals and the NRC’s associated Generic Environmental Impact Statement (NUREG-1437) supplement documents were reviewed to identify any SAMA candidates that were determined to be potentially cost-beneficial. The three most recent BWR SAMA submittals were selected to help ensure recent information is considered in the CPS SAMA analysis while an attempt to introduce diversity in approach was accomplished by including three additional SAMA submittals that were performed by analysts that did not work on the CPS SAMA analysis. The SAMAs from these sources were reviewed and included in the CPS SAMA list if they were considered to address potential risks not identified by the CPS importance list review.

The following six BWRs were used as the sources for the SAMAs:

- Duane Arnold Energy Center (FPL 2008, NRC 2010)
- Nine Mile Point, Unit 2 (CEG 2004, NRC 2006)
- Columbia Generating Station (ENW 2010, NRC 2012)
- Grand Gulf Nuclear Station (Entergy 2011, NRC 2013a)
- Fermi, Unit 2 (DTE 2014, NRC 2016a)
- River Bend (Entergy 2017, NRC 2018)

The cost-beneficial SAMAs from each of these sites are reviewed in the following subsections.

F.5.1.3.1 Duane Arnold Energy Center

Duane Arnold identified two SAMAs in the baseline analysis that were determined to be potentially cost-beneficial and one additional SAMA was identified as potentially cost-beneficial in the uncertainty analysis.

Review of Duane Arnold Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
117	Increase boron concentration or enrichment in the standby liquid control system.	The CPS design already uses an enriched boron solution, though two pumps must be operated to inject through at least one squib valve to meet the requirements of 10CFR50.62. Further enriching the boron solution could potentially increase the time available to inject boron, but this would have a minimal impact on risk. Level control and boron injection are both required to limit the heat load to containment in Anticipated Transient Without Scram (ATWS) events and the cues are the same for both actions (complete dependence between actions). Providing margin for boron injection initiaton would not provide significant benefit if level control is delayed because the early heat load to the containment would be higher.	Not required on SAMA list.
156	Provide an alternate source of water for the Residual Heat Removal Service Water (RHRSW)/Emergency Service Water (ESW) pit.	Already implemented. In the event that the SX suction area should become fouled and restrict flow to the pumps, a sluice gate can be opened to provide an alternate flow path to the SX suction area.	Not required on SAMA list.
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive	The intent of this SAMA is to reduce the probability that low pressure injection will be failed by the low pressure permissive sensors or logic. The low pressure permissive is modeled for CPS, but it is not a risk significant contributor and this type of enhancement would not be cost-beneficial for CPS.	Not required on SAMA list.

F.5.1.3.2 Nine Mile Point, Unit 2

Review of Nine Mile Point, Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
U2-23a	Provide redundant ventilation for residual heat removal (RHR) pump rooms	ECCS pump room cooling is not a large contributor for CPS, but a SAMA to provide temporary cooling to ECCS pump rooms has been included on the CPS SAMA list based on the importance list review.	Already Included.

Review of Nine Mile Point, Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
U2-23b	Provide redundant ventilation for high pressure core spray (HPCS) pump room	ECCS pump room cooling is not a large contributor for CPS, but a SAMA to provide temporary cooling to ECCS pump rooms has been included on the CPS SAMA list based on the importance list review.	Already Included.
U2-23c	Provide redundant ventilation for reactor core isolation cooling (RCIC) pump room	ECCS pump room cooling is not a large contributor for CPS, but a SAMA to provide temporary cooling to ECCS pump rooms has been included on the CPS SAMA list based on the importance list review.	Already Included.
U2-213	Enhance loss of service water procedure	For NMP-2, the loss of service water is related to the loss of room cooling for the RHR, HPCS, and RCIC systems and actions to perform alternate room cooling alignments were expected to be integrated with the loss of service water procedure. The CPS service water system design is different than for NMP-2 and the loss of service water initiating event is below the SAMA review threshold. No additional SAMAs are considered to be required to address loss of service water at CPS.	Not required on SAMA list.
U2-214	Enhance Station Blackout procedures	This SAMA was developed for NMP-2 to address plant specific procedure deficiencies for certain plant configurations, which at the time of the analysis, were addressed by compensatory measures. This is not expected to be applicable to the CPS electric power configuration. In addition, CPS constantly assesses and improves plant procedures as part of normal operations and the general intent of this SAMA is considered to be met for CPS.	Not required on SAMA list.
U2-215	Use of a portable charger for the batteries	Already implemented. The CPS FLEX strategy includes the use of portable generators to supply the battery chargers.	Not required on SAMA list.
U2-216	Hard pipe diesel fire pump to the reactor pressure vessel	A similar SAMA was developed based on the review of the CPS PRA results (SAMA 10). For CPS, a hard pipe connection is suggested to eliminate the need to perform the extensive work that is currently required to inject with the Fire Protection System.	Already included.

Review of Nine Mile Point, Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
U2-221a	Reduce unit cooler contribution to emergency diesel generator (EDG) unavailability by increasing the testing frequency	The CPS SX pumps and Diesel Generator (DG) Heating, Ventilating, Air Conditioning (HVAC) fans do not have outlier failure rates and the condition observed at NMP2 does not appear to exist at CPS. No opportunities for improvement in availability were identified in either the test frequencies or maintenance practices that would significantly impact component reliability.	Not required on SAMA list.
U2-221b	Reduce unit cooler contribution to EDG unavailability by providing redundant means of cooling	The redundant means of cooling represented by this SAMA is to open the EDG control panel room doors. For CPS, this action is directed, but not credited. CPS SAMA 1 provides a means of addressing DG HVAC failures via portable equipment.	Already included.
U2-222	Improve procedure for loss of instrument air	For NMP-2, the suggested loss of IA procedure enhancements would help maintain feedwater by including steps to isolate the min flow lines back to the condenser. For CPS, the loss of instrument air procedure could be enhanced to include the steps to isolate the min flow lines to help prevent this type of flow diversion.	Included on the SAMA list as SAMA 21.
U2-223	Improve control building flooding scenarios	The NMP-2 SAMA does not provide specific procedure enhancements and includes only general suggestions to move a firewater header or to install doors that would prevent water accumulation. For CPS, the significant flooding contributors are addressed in the importance list review and SAMAs were developed to address these events (e.g., SAMA 6).	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.

F.5.1.3.3 Columbia Generating Station

Review of Columbia Generating Station Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
AC/DC-28	Reduce common cause failures (CCFs) between EDG-3 and EDG-1/2	The description of the Columbia SAMA is to reduce CCF by providing separate fuel supplies, separate maintenance crews, and diverse instrumentation. For CPS, EDG CCF events are below the review threshold and the EDGs already have some elements of the Columbia SAMA, including EDG specific fuel tanks/fuel transfer systems and staggered/divisionalized maintenance practices. There are differences between the three CPS EDGs, for example, DIV I and II are tandem engines which have one 12 cylinder and one 16 cylinder engine connected to a common generator while DIV III is a single 16 cylinder engine; however, they are all included in the same common cause group despite these differences. Efforts to further differentiate the EDGs in the ways described by the SAMA would not appear to provide a sufficient basis for excluding or reducing the CCF probabilities and no measurable benefit would be expected from this SAMA.	Not required on SAMA list.
CC-03b	Raise RCIC backpressure trip set points	Allows RCIC to operate when suppression pool pressures are high enough to trip the RCIC turbine on high turbine exhaust pressure. The exhaust pressure trip is already directed to be defeated by procedure, if necessary, in post core damage conditions, which is a functional equivalent to further raising the setpoint. For extended loss of offsite power conditions, the FLEX strategy includes a means of cooling the suppression pool such that this would not be required. Loss of RCIC on high turbine exhaust pressure is not a risk-significant issue for CPS and this SAMA would not provide a significant benefit.	Not required on SAMA list.
FR-07a	Improve the fire resistance of critical cables for containment venting	The CPS SAMA list includes an enhancement to install a reliable hard pipe containment vent (SAMA 4) that will allow CPS to vent without support systems and is considered to address the intent of this SAMA.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.

Review of Columbia Generating Station Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
FR-07b	Improve the fire resistance of critical cables for transformer E-TR-S	The equivalent transformer for CPS may be the reserve auxillary transformers (RATs). In addition to the 3 RATS, CPS has an additional emergency reserve auxillary transformer (ERAT), which is physically separated from the RATs and provides a diverse source of power in emergency scenarios. In addition, most cases, one or more diesel generators would be available to provide power. Based on the importance review for the CPS fire model, installation of cable wrap on cables related to the RAT and ERAT has been suggested as a potential enhancement to protect against the significant fire contributors (SAMA 14).	Functional Equivalent Already Installed.Industry SAMA not added.
FR-08	Improve the fire resistance of cables to RHR and standby Service Water (SW)	For CPS, many of the dominant fires that impact suppression pool cooling/LPCI are those for which power has been lost to the system, but the failures are not related to RHR or service water cables. In such cases, there is no opportunity to protect the RHR system through the use of fire barriers or cable wrap on RHR components. For the remaining cases, implementation of other SAMAs will provide a viable containment heat removal path (e.g., SAMAs 4 and 8) and the risk of those fires will be reduced such that further reductions would likely not be cost-beneficial.	Not required on SAMA list.
HV-02	Provide redundant train or means of ventilation	This SAMA is for alternate switchgear room cooling. For CPS, switchgear room cooling is not required and the inverter rooms already have procedures to use portable equipment to provide cooling.	Not required on SAMA list.
SR-05R	Improve seismic ruggedness of MCC-7F and MCC-8F	Seismic risk is not a dominant contributor to CPS risk and this Columbia-specific SAMA would not provide a significant benefit for CPS.	Not required on SAMA list.
FL-05R	Clamp on flow instruments to certain drain lines in the control building of the radwaste building and alarm in the control room	Equivalent already implemented. The CPS Control Building and Radwaste Building have building sump pumps and water level alarms.	Not required on SAMA list.

Review of Columbia Generating Station Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
FL-04R	Add one isolation valve in the SW, turbine SW, and fire protection lines in the control building area of the radwaste building	The CPS PRA results review included an assessment of the important flood scenarios and remote flood isolation capability already exists for these contributors related to SX flooding. This SAMA is not required.	Not required on SAMA list. Capability already exists at CPS.
CC-24R	Backfeed the HPCS system with SM-8 to provide a third power source for HPCS	For CPS, the HPCS system can be cross-tied to provide power for containment heat removal, but CPS does not include a cross-tie process for powering HPCS from Div I or Div II buses. This cross-tie has already been included on the CPS SAMA list.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
CC-25R	Enhance alternate injection reliability by including RHR, SW and fire water cross-tie in the maintenance program	For CPS, the Fire Protection and Service Water system cross-tie valves to RHR are negligible contributors to risk. Changes to maintenance practices would not result in a significant change in plant risk.	Not required on SAMA list.
OT-07R	Increase operator training on systems and operator actions determined to be important from the Probabilistic Safety Assessment	Important Human Failure Events (HFEs) are currently communicated to CPS Operations and consideration is given to improving the response to those actions. These actions are validated with respect to the time required to implement them, but not necessarily given additional training and simulator practice. The quantitative benefits associated with improving training in HRA are subjective and reliability improvements are generally limited to Cases where training can be provided for actions that are not currently practiced. The HFEs important to CPS risk were reviewed and addressed as part of the importance list review.	Not required on SAMA list.
FW-05R	Examine the potential for operators to control reactor feedwater (RFW) and avoid a reactor Trip	For CPS, the transient initiating event frequencies are based on plant specific and industry data such that potential improvements to the operators' ability to control FW would not directly be reflected in the risk assessment and the benefit of such an improvement cannot be estimated reliably. No control issues have been identified for CPS and this SAMA is not considered to be required.	Not required on SAMA list.

Review of Columbia Generating Station Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
OT-09R	For the non-Loss of Coolant Accident initiating events, credit the Z (power conversion system recovery) function	This appears to be a PRA model enhancement rather than a plant enhancement. The power conversion system is modeled and credited in the CPS model. Not relevant.	Not required on SAMA list.
FR-11R	Install early fire detection in the following analysis units: RC-02, RC-03, RC-04, RC-05, RC-07, RC-08, RC-11, RC-13, RC-14, and RC-1A	For the CPS fire contributors, other SAMAs have been identified that address the consequences of the fires/prevent propagation, and the risk is considered to be addressed by those SAMAs. The reliability of early detection systems has not been established and these types of changes are not recommended as SAMAs.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.

F.5.1.3.4 Grand Gulf

Review of Grand Guld Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
39	Change procedure to cross tie open cycle cooling system to enhance containment spray system.	It is not clear from the Grand Gulf SAMA analysis whether the intent of this SAMA is to cross-tie an open cycle system to RHR in order to supply the containment spray header, or to provide the RHR heat exchangers with an alternate cooling supply. Both potential enhancements are already implemented at CPS. CPS has a procedure for aligning the shutdown service water system to containment spray in emergency situations. The FLEX procedures also provide a means of using the ultimate heat sink and a portable pump to provide RHR HX cooling.	Not required on SAMA list.

Review of Grand Guld Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
42	Enhance procedures to refill condensate storage tank from demineralized water or service water system	CPS has the capability (with procedures) to provide makeup to the Condensate Storage Tank (CST) with the Cycled Condensate System (normal) and Fire Water via the FLEX procedures. For Extended Loss of AC Power (ELAP) scenarios, the RCIC storage tank is assumed to be unavailable and additional makeup capability would not be helpful. The SAMA list already includes a change to protect the RCIC storage tank such that it could be used in ELAP (and make use of the Fire Protection System (FPS) makeup capability. For FPIE scenarios, lack of a RCIC suction source is a negligible contributor. For Fire events, updating the procedure to use the FPS to provide RCIC makeup in non-ELAP scenarios could be beneficial, and this change is already included on the SAMA list.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
59	Increase operator training for alternating operation of the low pressure emergency core cooling system pumps (low-pressure coolant injection and low pressure core spray) for loss of standby service water scenarios	For CPS, the low pressure ECCS pumps are cooled by the Shutdown Service Water System. Rather than cycling large pumps in scenarios where the cooling system is lost, a more effective means of maintaining injection with the ECCS pumps is considered to be through the use of portable/temporary cooling alignment, which is addressed by CPS by SAMA 13.	Not required on SAMA list.
Un-numbered	Revise procedures to direct the operator monitoring a running diesel generator to ensure that the ventilation system is running or take action to open doors or use portable fans	The failure of diesel generator room cooling fans are risk significant contributors for CPS, but high DG room temperature alarms are available that would alert the crew to loss of cooling. SAMA 1 has been included to procure portable fans to provide alternate room cooling based on the plant importance list review.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.

F.5.1.3.5 Fermi, Unit 2

Review of Fermi Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
206	Improve the ability of operators to manually close a damper to isolate the third floor of the reactor building from hardened vent path	The CPS vent path/process is different than for Fermi and this SAMA is not applicable to the CPS design.	Not required on SAMA list.
112	Revise EOPs to improve ISLOCA identification.	The SAMA was assumed to reduce ISLOCA risk by 25%, but no details were provided with respect to the actual plant/procedure enhancements that would be made to realize this risk reduction. The CPS ISLOCA contributors were reviewed and event identification is not a major factor in mitigation. Execution time related to breaker alignment to support injection and the inability of valves to isolate the breaks are the important factors for CPS ISLOCA events, which are addressed by separate SAMAs.	Not required on SAMA list.
113	Improve operator training on ISLOCA coping	The SAMA was assumed to reduce ISLOCA risk by 25%, but no details were provided with respect to the actual plant/procedure enhancements that would be made to realize this risk reduction. The CPS ISLOCA contributors were reviewed, and the dominant issue is the lack of a long-term water supply for injection systems that are successfully initiated. SAMA 18 was developed to provide a means of supplying the operating systems with a high-volume makeup supply to the RCIC storage tank.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.

Review of Fermi Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
115	Revise procedures to control vessel injection to prevent boron loss or dilution following SLC injection	The actions to restore/control RPV water level after liquid boron injection are modeled in the CPS PRA. The CPS EOP bases document includes a statement that RPV level should be increased slowly to avoid displacement of boron from the core when restoring RPV level after boron injection, and while it may be possible to provide additional clarification on the level restoration process in the procedure text, changes to the procedures and/or training would have no measurable impact on the associated HEPs. The procedure interface error contributions are low/minor contributors to the current HEPs and further changes to the procedures would not alter the HEP quantifications. This SAMA would provide no measurable benefit for CPS.	Not required on SAMA list.
Unnumbered from NUREG-1437 Supplement 56	Install a flood barrier or curb between the DC switchgear room and Division 2 AC switchgear room.	This is a Fermi-specific flood mitigation SAMA. For CPS, auxiliary building flooding events are below the SAMA review threshold, and no SAMAs are required. The important CPS internal flooding scenarios are related to MCR flooding and they are addressed by SAMAs derived from the importance list review.	Not required on SAMA list.
Unnumbered from NUREG-1437 Supplement 56	Develop a new procedure to close valves to terminate the flood from EECW in an AB3 switchgear room.	This is a Fermi-specific flood mitigation SAMA. For CPS, auxiliary building flooding events are below the SAMA review threshold, and no SAMAs are required. The important CPS internal flooding scenarios are related to MCR flooding and they are addressed by SAMAs derived from the importance list review.	Not required on SAMA list.

Review of Fermi Unit 2 Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
Unnumbered from NUREG-1437 Supplement 56	Revise existing alarm response procedures to direct operators to DC switchgear room and the Division 2 AC switchgear room following indication of leakage in RBCCW/EECW system piping	This is a Fermi-specific flood mitigation SAMA. For CPS, auxiliary building flooding events are below the SAMA review threshold, and no SAMAs are required. The important CPS internal flooding scenarios are related to MCR flooding and they are addressed by SAMAs derived from the importance list review.	Not required on SAMA list.

F.5.1.3.6 River Bend

Review of River Bend Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
94a	Enhance procedures for actions on loss of HVAC (HPCS)	This is similar to SAMA 13, which provides portable HVAC with supporting procedures.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
94b	Enhance procedures for actions on loss of HVAC (RHR B/C)	This is similar to SAMA 13, which provides portable HVAC with supporting procedures.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
94c	Enhance procedures for actions on loss of HVAC (LPCS, RHR A)	This is similar to SAMA 13, which provides portable HVAC with supporting procedures.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
97	Perform study and analysis to add steps to trip unneeded ECCS pumps on loss of HVAC	There is currently no basis to confirm that tripping unneeded pumps would prevent room temperature from exceeding levels that would lead to pump damage. SAMA 13 includes room heatup analysis that could potentially determine if this alternate approach is feasible, and it has been included in the proposed design.	Industry SAMA Design Element Added to existing SAMA 13.

Review of River Bend Potentially Cost-beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for CPS	Disposition for CPS SAMA List
102	Operator procedure revisions to provide space cooling to the EDG room via the use of portable equipment.	The plant specific importance list review has already identified a SAMA to provide portable HVAC equipment and supporting procedures for the EDG rooms.	Functional Equivalent Already Included on the SAMA list; Industry SAMA not added.
169	Improve internal flooding procedures	Internal flooding contributors were reviewed as part of the CPS importance list review and SAMAs were developed to address them. Procedure improvements alone were not viable candidates to reduce risk.	Not required on SAMA list.
185	Upgrade the alternate shutdown panel to include additional system control for the opposite division	The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.	Included as SAMA 22.
198	Develop a procedure for alternating operation of low pressure ECCS pumps for loss of SSW	RHR pumps do not require seal cooling for the PRA mission time and low-pressure core spray uses water from the pump discharge for the seals and no seal cooling dependencies exist on other systems. Room cooling is addressed by SAMA 13.	Not required on SAMA list.
205	Revise FLEX procedures to allow use of FLEX in non-ELAP conditions	CPS already directs use of the portable/FLEX pumps in non-ELAP conditions. Use of other FLEX equipment, such as the portable generators, could be allowed in non-ELAP scenarios, but loss of power events that would benefit from FLEX equipment are dominated by Station Blackout (SBO)/ELAP events, which already use FLEX equipment. Use of the Fire Protection system to refill the RCIC storage tank in non-ELAP scenarios is a potential enhancement that was already identified in the review of the Fire importance list review.	Not required on SAMA list.
5.b.ii	Improve procedures and training on injection with the fire water system	Training is not a limiting factor for use of the Fire Protection System for RPV injection at CPS.	Not required on SAMA list.

F.5.1.3.7 Industry SAMA Identification Summary

The important issues for CPS are generally considered to be addressed by the SAMAs developed through the PRA importance list review. The plant changes suggested as part of that review were developed to meet the specific needs of the plant, such that those SAMAs are more likely to provide effective means of risk reduction than SAMAs taken from other sites. However, effort was made to review other industry SAMA analyses to determine if other sites identified plant changes that could be potentially cost-beneficial for CPS based on modeling differences or other factors. For CPS, the industry review identified two (2) unique plant enhancements that have been included in the Phase 1 SAMA list for consideration:

- Address Flow FW Diversion in the Loss of Instrument Air Procedure (SAMA 21)
- Upgrade the alternate shutdown panel to include additional system control for the opposite division (SAMA 22)

F.5.1.4 CPS IPE PLANT IMPROVEMENT REVIEW

The CPS IPE submittal (IP 1992) includes several proposed plant improvements, most of which of which have been implemented. The exception is the enhancement to provide a bypass line around a check valve that is in the flowpath use to provide fire protection system injection to the RPV; however, a SAMA has been generated for CPS that is functionally equivalent to this enhancement and the SAMA analysis addresses the issue.

Description of Potential Enhancement	Status of Implementation	Disposition
Provide training on switchyard activities with the potential to interrupt offsite power.	Implemented	No further review required.
Include HPCS suction line from the suppression pool in plant surveillance tests.	Implemented	No further review required.
Emphasize importance of manual, emergency RPV depressurization to the operators.	Implemented	No further review required. CPS has removed the EOP direction to inhibit Automatic Depressurization System (ADS) in non-ATWS scenarios and depressurization is highly trained in ATWS.

Description of Potential Enhancement	Status of Implementation	Disposition
Provide a bypass line around check valve 1FP036 to allow rapid alignment of FPS for RPV injection	Not Implemented	Functional equivalent already included on CPS SAMA list (SAMA 10)
Emphasize training on EDGs/auxiliary power supplies to improve reliability of AC power recovery	Implemented	No further review required.
Procedure enhancement to confirm SX pump start after EDG start	Implemented	No further review required.
Emphasize importance of training related to manual isolation of fuel pool cooling and cleanup line in station blackout conditions	Implemented	No further review required.
Emphasize importance of training for SCRAM system maintenance	Implemented	No further review required.

For CPS, the IPE enhancements have either been implemented, obviated by other plant changes, or are accounted for on the CPS SAMA list such that it was not necessary to explicitly add any of the IPE changes to the CPS SAMA list.

F.5.1.5 CPS IPEEE PLANT IMPROVEMENT REVIEW

The CPS IPEEE (IP 1995) did not identify any additional plant improvements for potential implementation at the site. The plant was determined to be fully capable of attaining safe shutdown conditions after the Review Level Earthquake (RLE) and further changes were not considered to be necessary. Likewise, no changes were identified for internal fires, which was attributed, in part, to the good physical separation of the different electrical divisions. Cable rerouting work, which was scheduled to be performed as part of an initiative separate from the IPEEE, was identified in the fire analysis and the CDF estimates accounted for “before” and “after” conditions related to this work. No plant modifications were made or suggested as a result of the “Other Hazards Analysis”.

In conclusion, there are no unimplemented SAMAs from the CPS IPEEE to consider for the SAMA analysis.

F.5.1.6 EXTERNAL EVENTS IN THE CPS SAMA ANALYSIS

The fire contributors are addressed in the CPS SAMA analysis via the importance list review for SAMA identification and the PRA results are used directly in the MACR and averted cost risk calculations. Other hazards, including seismic risk, are addressed in the current CPS External Hazards Assessment (Exelon 2020). None of these "other" hazards required the development of detailed PRA models.

The general approach to estimation of the seismic CDF was to use the plant level High Confidence Low Probability of Failure and convolve the corresponding failure probabilities as a function of seismic hazard level with the seismic hazard curve. Seismic LERF was based on a seismic conditional large early release probability that was based on some high-level plant information, but neither the CDF nor LERF calculations provided plant-specific insights that SAMAs were useful in the identification of SAMAs, and none were proposed for this analysis.

The high winds and tornado assessment developed frequencies of tornado generated missiles impacting important systems, but these were not core damage frequencies and the impact frequencies were less than 1E-6/yr. Hence, no SAMAs were identified.

The remaining hazards were screened from further analysis using a progressive screening approach and no SAMAs are considered to be required for these hazards for CPS.

The hazards that were screened from further consideration are as follows: aircraft impact, avalanche, biological event, coastal erosion, drought, external flooding, fog, forest or range fire, frost, hail, high summer temperature, high tide/lake level/river stage, hurricane, ice cover, industrial or military facility accident, landslide, lightning, low lake level or river stage, low winter temperature, meteorite or satellite, pipeline accident, release of chemicals in onsite storage, river diversion, sand or dust storm, seiche, snow, solid shrink-swell consolidation, storm surge, toxic gas, transportation accident, tsunami, turbine-generated missiles, volcanic activity, and waves.

F.5.2 PHASE 1 SCREENING PROCESS

The initial list of SAMA candidates is presented in Table F.5-3. The process used to develop the initial list is described in Section F.5.1.

The purpose of the Phase 1 analysis is to use high-level knowledge of the plant and SAMAs to preclude the need to perform detailed cost-benefit analyses on them. The following screening criteria were used:

- Applicability to the Plant: If a proposed SAMA does not apply to the CPS design, it is not retained. Similarly, any SAMAs that have already been implemented by CPS or any modifications implemented by CPS that achieve the same results as a SAMA can be screened out as they are not applicable to the current plant design. These criteria are not often explicitly used in the Phase I analysis because the SAMA identification methodology generally excludes such SAMAs; however, they are listed as a possible screening method given that there may be circumstances in which a SAMA would be included in the list even if it is not relevant to the site. An example may be the inclusion of a high-profile SAMA that is well known in the industry, but not applicable to the specific site design. Such a SAMA may be included for documentation purposes. Another example may be an unimplemented SAMA from the IPE that has been superseded by another plant enhancement.
- Implementation Cost Greater than Screening Cost: If the estimated cost of implementation is greater than the MACR (refer to Section F.4.6), the SAMA cannot be cost-beneficial and is screened from further analysis.

Table F.5-3 provides a description of how each SAMA was dispositioned in Phase 1 (Zero (0) SAMAs were screened out on excessive implementation cost). Those SAMAs that required a more detailed cost-benefit analysis are passed to the Phase 2 analysis and evaluated in Section F.6. Table F.6-1 contains the Phase 2 SAMAs.

F.6 PHASE 2 SAMA ANALYSIS

The SAMA candidates identified as part of the Phase 2 analysis are listed in Table F.6-1. The base PRA model was manipulated to simulate implementation of each of the proposed SAMAs and then quantified to determine the risk benefit. The base PRA truncation levels were raised to 5E-12/yr for FPIE CDF and FPIE LERF and 5E-11/yr for Fire CDF and Fire LERF to better support the Phase 2 SAMA sensitivities (baseline results were recalculated using the revised truncation levels).

In general, in order to maximize the potential risk benefit due to implementation of each of the SAMAs, the failure probabilities assigned to new basic events, such as HEPs, were optimistically chosen so as not to inadvertently screen out any potential cost-beneficial SAMAs. Also, any new model logic that was added to the PRA model in order to simulate SAMA implementation was also simplified and optimistically configured to achieve the same effect.

Determining whether any given Phase 2 SAMA is potentially cost-beneficial involved calculating what is known as the averted cost-risk, which was obtained by a multi-step process that includes the use of the baseline MACR as well as the internal events PRA results, internal fire PRA results, and a multiplier to account for non-fire external events contributions.

- The averted cost-risk is the difference between the baseline MACR and the MACR for the configuration in which the SAMA has been implemented ($MACR_{SAMA}$). The $MACR_{SAMA}$ includes the internal events contribution, internal fire contributions, and the non-fire external events contribution.
- The internal events and internal fire portion of the $MACR_{SAMA}$ is calculated in the same manner as for the baseline MACR using the CDF, Level 2 PRA results, etc., as shown in Sections F.4.1 through F.4.6.1.
- The contribution from the non-fire external events to the $MACR_{SAMA}$ is accounted for by multiplying the internal events and internal fire $MACR_{SAMA}$ by the non-fire External Events Multiplier (refer to section F.4.6.2).

Finally, a SAMA is determined to be potentially cost-beneficial if its net value is positive. The net value is determined by the following equation:

$$\text{Net Value} = \text{averted cost-risk} - \text{cost of implementation}$$

The implementation costs used in the Phase 1 and 2 analyses consist of industry estimates, CPS specific estimates, or in some cases, combinations of these two sources. It should be noted that CPS specific implementation costs are based on conceptual designs, <u>do</u> include contingency costs for unforeseen difficulties,, but do <u>not</u> account for any replacement power costs that may be incurred due to consequential shutdown time unless specifically noted. Table F.5-3 provides implementation costs for each Phase 1 and Phase 2 SAMA.

The following sections describe the cost-benefit analysis that was used for each of the Phase 2 SAMA candidates.

F.6.1 SAMA 1: PROVIDE PORTABLE HVAC EQUIPMENT AND SUPPORTING PROCEDURES FOR ALTERNATE DG ROOM COOLING

For scenarios involving loss of room cooling for the EDGs, providing a diverse, portable fan/ductwork to indefinitely maintain room temperature in the acceptable range would prevent SBO/loss of 4KV power due to HVAC failures.

Assumptions:

Operator action 1DGOP-VDD1DR-H-- (OP FAILS TO OPEN DIV1 DG ROOM DOORS GIVEN FAN FAILURE) is an action that is already in the fire model to mitigate DG room fan failures. For this SAMA, it is assumed the action that represents not only the opening of DG room doors, but also the alignment of any portable fans and ductwork that may be required to ensure adequate cooling is available.

PRA Model Changes to Model SAMA:

The model was modified to incorporate this SAMA by eliminating the support system dependencies, improving the reliability of the venting action to reflect simplification of the controls, and eliminating the events related to vent path rupture and leakage.

Model Change(s):

The following changes were made to the fault tree:

- Gate AGATE44: Added an OR gate above this gate and moved the Div. 1 VD damper events under gate AGATE29 under the new OR gate (SAMA-01-A).
- Gate AGATE45: Added an OR gate above this gate and moved the Div. 2 VD damper events under gate AGATE30 under the new OR gate (SAMA-01-B).
- Replaced gate AGATE45-RMCLG under gate AGATE45-DOOR with gate HFE-084.
- Gate AGATE46: Added an OR gate above this gate and moved the Div. 3 VD damper events under gate AGATE31 under the new OR gate (SAMA-01-C).
- Replaced gate AGATE46-RMCLG under gate AGATE46-DOOR with gate HFE-084.
- HFE 1DGOP-VDD1DR-H—now represents aligning portable duct work and opening the doors for any DG room (failure to do the action for 1 DG room results in failure for all DG rooms).

The following changes were made to the FPIE flag file:

- Removed 1DGOP-VDD1DR-H--, F-D-4A-RM-CLG-FAILS, and F-D-6A-RM-CLG-FAILS from the FPIE flag file.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR(Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.35E-06	7.75E-05	7.99E-05	67.80	$957,468
Percent Reduction	19.2%	0.1%	0.8%	0.6%	0.6%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,815
ST2 - H/E	6.27E-08	9.00E-07	9.63E-07	1.57E+00	$24,934
ST3 - H/L	3.69E-07	2.63E-05	2.67E-05	4.35E+01	$690,727
ST4 - M/E	1.48E-07	1.90E-05	1.91E-05	1.58E+01	$199,139
ST5 - M/L	3.67E-07	2.16E-05	2.19E-05	5.97E+00	$37,512
ST6 - L/E	1.86E-07	2.64E-06	2.83E-06	4.21E-01	$1,933
ST7 - L/L	1.54E-07	2.24E-06	2.39E-06	1.83E-01	$699
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.31E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	9.79E-07	4.00E-07	1.38E-06	2.39E-03	$19
Total	**1.37E-06**	**7.71E-05**	**7.85E-05**	**6.78E+01**	**$957,468**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,468,600. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,468,712. The "other" external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$ * 1.079 = \$25,322,740$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 1 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,322,740	$161,082

Based on an implementation cost of $399,746, the net value would be -$238,664 ($161,082 - $399,746), implying that SAMA 1 is not cost-beneficial.

F.6.2 SAMA 2: PROCEDURALIZE DC CURRENT CHECK FOR ELAP LOAD SHED ACTION

Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.

The modeling of the DC load shed action in the PRA includes some conservative assumptions related to the failure mode of the action and the action's timing requirements – specifically, failure to shed any load within the time assumed in the battery life calculations results in failure of the action even if the load is small would not necessarily preclude success. Similarly, if a breaker is opened shortly after the assumed time limit for the action, the action is still assumed to be failed. While these assumptions may oversimplify and overestimate the probability of failure of the load shed action, the model highlights the action's importance and including a verification that the action has been completed successfully is considered to be a good practice approach to managing plant risk.

<u>Assumptions:</u>

The HEP for the action has been revised by updating the recovery step to represent a procedure-based check and if the current is identified as being out of range, it is assumed that the breaker omission(s) will be recovered. Because the current check would be performed by a different person, in a different location, and using instruments that are separate from the controls manipulated to complete the action, zero dependence is assumed to exist between manipulation errors and the current check step.

PRA Model Changes to Model SAMA:

The HEP was reduced from 6.3E-01 to 3.8E-02 (FPIE) and 3.0E-01 (Fire) based on the inclusion of the procedure step to confirm that battery current is within the correct range.

- Updated independent HEPs.
- Updated relevant dependent action combinations (Joint HEPs).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.69E-06	7.27E-05	7.54E-05	63.21	$896,185
Percent Reduction	7.6%	6.3%	6.4%	7.3%	7.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	6.83E-08	9.00E-07	9.68E-07	1.58E+00	$25,079
ST3 - H/L	5.29E-07	2.55E-05	2.60E-05	4.24E+01	$674,151
ST4 - M/E	1.50E-07	1.47E-05	1.49E-05	1.22E+01	$154,440
ST5 - M/L	3.05E-07	2.15E-05	2.18E-05	5.94E+00	$37,338
ST6 - L/E	2.28E-07	2.59E-06	2.82E-06	4.20E-01	$1,928
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.18E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.10E-06	8.00E-07	1.90E-06	3.28E-03	$26
Total	**1.59E-06**	**7.19E-05**	**7.35E-05**	**6.32E+01**	**$896,185**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $21,959,483. After accounting for “round up” of the base internal events and fire cost-risk, this value is $21,959,595. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$21,959,595 * 1.079 = \$23,694,403$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 2 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$23,694,403	$1,789,419

Based on a $50,000 cost of implementation for CPS, the net value for this SAMA is $1,739,419 ($1,789,419 - $50,000), which indicates this SAMA is potentially cost-beneficial.

F.6.3 SAMA 3: PROTECT THE RCIC STORAGE TANK AND PROVIDE LONG TERM MAKEUP

While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.

Assumptions:

If the RCIC storage tank is protected, it provides an additional means of providing makeup, and if containment venting is used with it, and alternate means of containment heat removal. If the current FLEX strategy fails, RCIC may be used taking suction from the RCIC storage tank and Containment Vent path #6 (unscrubbed) is assumed to be made available by powering the busses the support valve operation with the FLEX generators.

The existing containment venting action using vent path #6 is adequate for modeling the venting action for this SAMA.

The FLEX generator can support the containment vent valve load or loads will be shed by procedure to support vent valve operation, when required.

The RCIC storage tank has adequate inventory for the mission time.

DC load shed is still required for success as it will provide power to the batteries to maintain RCIC control/instrumentation until the FLEX generator is aligned.

PRA Model Changes to Model SAMA:

In order to approximate the impact of a having RCIC as the injection source from the RCIC storage tank with the containment vent providing heat removal, the current FLEX gate logic has been ANDed with new, simplified logic that captures the major events/support systems required for operations.

Model Change(s):

The following changes were made to the fault tree:

- Gate RCIC-RHRA-FLEX: Added a new AND gate (RCIC-RHRA-FLEX-1) above gate RCIC-FLEX-RHRA-PATH. Gate UGATE23L added under this new AND gate.
- Gate RCIC-RHRB-FLEX: Added a new AND gate (RCIC-RHRB-FLEX-1) above gate RCIC-FLEX-RHRB-PATH. Gate UGATE23L added under this new AND gate.
- Gate RCICT-FLEX-SBO: Added new AND gate SAMA-03-BOTH and deleted gate RCICT-FLEX.
- New AND gate SAMA-03-BOTH: includes existing gate RCICT-FLEX and new gate OR SAMA-3-RCIC-VT.
- New OR gate SAMA-3-RCIC-VT: Includes existing gates RCICL, U2-LT-FLEX, and HFE-057, and new OR gate SAMA-3-VENT.
- New OR gate SAMA-3-VENT: Includes existing gates OP-INIT-VENT and FGATE-TT3, and new OR gate SAMA-3-VENT-1.
- New OR gate SAMA-3-VENT-1: includes existing gates/events HFE-022 and 1VRFL-1VR05M-P-- and new OR gate SAMA-3-VENT-2.
- New OR gate SAMA-3-VENT-2: includes existing event 1VRDM-1VR04Y-D-- and new OR gates SAMA-3-VENT-VLV6A and SAMA-3-VENT-VLV6B.
- New OR gate SAMA-3-VENT-VLV6A: includes existing event 1VRAV-1VR006AD-- and new OR gate SAMA-VENT-VLV6A-1.
- New OR gate SAMA-3-VENT-VLV6B: includes existing events 1VRAV-1VR006BD-- and 1CVPH-TEMPF--F-- and new OR gate SAMA-VENT-VLV6B-1.
- New OR gate SAMA-VENT-VLV6A-1: Includes existing gates/events 1IAAV-IA005--D--, 1IAAV-IA006--D--, and FLEX-PWR-BUS1F.

- New OR gate SAMA-VENT-VLV6B-1: Includes existing gates/events 1IAAV-IA005--D--, 1IAAV-IA006--D--, and FLEX-PWR-BUS1G.
- Gate RCICT-FLEX-RSDP: Added new AND gate RCIC-FLEX-RSDP-SAMA-3. Deleted gate RCIC-FLEX-RSDP.
- New AND gate RCIC-FLEX-RSDP-SAMA-3: Includes existing gate RCIC-FLEX-RSDP and new OR gate RCIC-FLEX-RSDP-SAMA-3-1.
- New OR gate RCIC-FLEX-RSDP-SAMA-3-1: Includes existing gates HFE-093, U2-LT-FLEX, HFE-057, and RCICL, plus new OR gate SAMA-3-VENT (described above).

The following changes were made to the Flag File:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

The following changes were made to the cutsets:

- Based on a detailed review of Fire combo FDEPGROUP-COMB013, the event order in the assessment HRA been changed to place the breaker operation first followed by the load shed action since SBO does not occur until after failure of the breaker manipulation leads to loss of AC power. High dependence between the actions is retained and the revised Joint Human Error Probability (JHEP) is 2.7E-2 (down from 3.9E-2).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.42E-06	7.45E-05	7.69E-05	67.70	$965,994
Percent Reduction	16.8%	4.0%	4.5%	0.7%	-0.3%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.20E-08	9.01E-07	9.83E-07	1.60E+00	$25,464
ST3 - H/L	4.64E-07	2.76E-05	2.80E-05	4.57E+01	$725,854
ST4 - M/E	1.62E-07	1.66E-05	1.68E-05	1.38E+01	$174,616

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST5 - M/L	3.70E-07	1.99E-05	2.02E-05	5.50E+00	$34,580
ST6 - L/E	3.90E-07	3.15E-06	3.54E-06	5.27E-01	$2,419
ST7 - L/L	9.33E-08	1.84E-06	1.93E-06	1.48E-01	$564
ST8 - LL/E	2.18E-09	3.01E-07	3.03E-07	2.29E-02	$76
ST9 - LL/L	4.16E-08	4.04E-06	4.08E-06	1.94E-01	$592
ST10 - INTACT	7.76E-07	2.29E-07	1.00E-06	1.74E-03	$14
Total	**1.64E-06**	**7.43E-05**	**7.59E-05**	**6.77E+01**	**$965,994**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,504,678. After accounting for “round up” of the base internal events and fire cost-risk, this value is $23,504,790. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23{,}504{,}790 * 1.079 = \$25{,}361{,}668$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 3 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,361,668	$122,154

Based on a $8,915,554 cost of implementation for CPS, the net value for this SAMA is -$8,793,400 ($122,154 - $8,915,554), which indicates this SAMA is not cost-beneficial.

F.6.4 SAMA 4: ENHANCE CONTAINMENT VENTING CAPABILITY (E.G., FLEX HARDPIPE VENT)

The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.

Assumptions:

This SAMA can be modeled using a lumped event with a failure probability of 0.5 that represents hardware failures, independent operator action failure, and dependent operator action failures.

PRA Model Changes to Model SAMA:

The flag event that is used to identify the inability of other CPS containment vent paths to remove adequate heat/pressure from the containment has been changed from a TRUE event to a basic event with a probability of 0.5.

Note: Different failure probabilities could be proposed/supported for the containment venting function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following modeling changes were made:

- 1CVPH-SMALLD-F-- (SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4): Basic event changed from TRUE to have a probability of 0.5.

SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.60E-06	6.30E-05	6.56E-05	46.38	$624,462
Percent Reduction	10.7%	18.8%	18.5%	32.0%	35.2%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.01E-08	5.00E-07	5.80E-07	9.46E-01	$15,025
ST3 - H/L	2.75E-07	1.41E-05	1.44E-05	2.34E+01	$372,313
ST4 - M/E	1.57E-07	1.90E-05	1.92E-05	1.58E+01	$199,233

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST5 - M/L	2.12E-07	1.89E-05	1.92E-05	5.21E+00	$32,750
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	1.65E-07	1.77E-06	1.94E-06	1.48E-01	$565
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.30E-06	1.60E-06	2.90E-06	5.01E-03	$40
Total	**1.30E-06**	**6.14E-05**	**6.27E-05**	**4.64E+01**	**$624,462**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $15,902,753. After accounting for "round up" of the base internal events and fire cost-risk, this value is $15,902,865. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$15,902,865 * 1.079 = \$17,159,191$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 4 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$17,159,191	$8,324,631

Based on a $12,940,000 cost of implementation for CPS, the net value for this SAMA is -$4,615,369 ($8,324,631 - $12,940,000), which indicates this SAMA is not cost-beneficial.

F.6.5 SAMA 5: INSTALL AN EMERGENCY TIE LINE FROM THE SWITCHYARD TO AN EMERGENCY BUS

The process to restore offsite AC power (OSP) to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.

Assumptions:

It is assumed that this SAMA reduces the execution time for the bus realignment action from 60 minutes to 30 minutes, which will provide for more recovery time to the operators. Based on a review of the evaluation of the existing action in the HRAC, the reduction in execution time in combination with the consideration of potential recovery steps resulted in a reduction of the HEP from 6.2E-02 to 1.5E-02.

PRA Model Changes to Model SAMA:

The addition of the emergency tie line has been modeled by reducing the HEP associated with the alignment action.

Model Change(s):

The following modeling changes were made:

- 1APOP-OSP-RX-H-- (OPERATOR FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RECOVERY OF OSP): Basic event probability changed from 6.2E-02 to 1.5E-02.
- Relevant JHEP values were updated with revised HEP.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	**Fire CDF**	**CDF (Total)**	**Dose-Risk (Total)**	**OECR (Total)**
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.73E-06	7.66E-05	7.93E-05	67.29	$951,111
Percent Reduction	6.2%	1.3%	1.5%	1.3%	1.3%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	**FPIE $Freq._{SAMA}$**	**Fire $Freq._{SAMA}$**	**Total $Freq._{SAMA}$**	**Dose-$Risk_{SAMA}$**	**$OECR_{SAMA}$**
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	7.99E-08	9.00E-07	9.80E-07	1.60E+00	$25,379
ST3 - H/L	4.83E-07	2.61E-05	2.66E-05	4.33E+01	$688,500
ST4 - M/E	1.61E-07	1.86E-05	1.88E-05	1.54E+01	$195,114
ST5 - M/L	3.59E-07	2.12E-05	2.16E-05	5.86E+00	$36,866
ST6 - L/E	3.15E-07	2.63E-06	2.95E-06	4.39E-01	$2,014

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST7 - L/L	2.12E-07	2.22E-06	2.43E-06	1.86E-01	$710
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.36E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.04E-06	5.00E-07	1.54E-06	2.66E-03	$21
Total	**1.69E-06**	**7.61E-05**	**7.78E-05**	**6.73E+01**	**$951,111**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,307,038. After accounting for “round up” of the base internal events and fire cost-risk, this value is $23,307,150. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23{,}307{,}150 * 1.079 = \$25{,}148{,}415$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 5 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,148,415	$335,407

Based on a $400,000 cost of implementation for CPS, the net value for this SAMA is -$64,593 (335,407 - $400,000), which indicates this SAMA is not cost-beneficial.

F.6.6 SAMA 6: PROVIDE FLOOD PROTECTION FOR MCR HVAC DUCTS

A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.

Assumptions:

Performing improvements on the HVAC ductwork will reduce the probability that water will penetrate into the MCR and lead to abandonment, but it will not necessarily be a "perfect" fix. The frequency of a significant flooding event into the MCR is assumed to be reduced by a factor of 5.

PRA Model Changes to Model SAMA:

The impact of the improved HVAC ductwork is represented in the PRA by reducing the probability of a failure to safely shut the plant down when a flood occurs by factor of 5.

Note: Different failure probabilities could be proposed/supported for the flood protection strategy proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following change was made to the cutset files:

- 1MCR-ABANDON (FLOOD (MAJOR) IN CB-1I CAUSES ABANDONMENT IN MCR): Probability changed from 5E-02 to 1E-02.
- No impact on the fire model (the event is for mitigating internal flooding events).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.44E-06	7.76E-05	8.00E-05	68.18	$963,117
Percent Reduction	16.2%	0.0%	0.6%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	7.99E-08	9.00E-07	9.80E-07	1.60E+00	$25,379
ST3 - H/L	5.26E-07	2.63E-05	2.68E-05	4.37E+01	$694,793
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	5.94E+00	$37,365
ST6 - L/E	3.29E-07	2.64E-06	2.97E-06	4.42E-01	$2,031
ST7 - L/L	1.84E-07	2.23E-06	2.41E-06	1.84E-01	$705
ST8 - LL/E	8.40E-10	3.50E-07	3.51E-07	2.65E-02	$88
ST9 - LL/L	1.89E-08	4.10E-06	4.12E-06	1.96E-01	$597
ST10 - INTACT	7.30E-07	5.00E-07	1.23E-06	2.13E-03	$17
Total	**1.71E-06**	**7.71E-05**	**7.88E-05**	**6.82E+01**	**$963,117**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,597,173. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,597,285. The external events contributions are accounted for by multiplying this value by 1.079:

Total Cost-Risk$_{SAMA}$ = $23,597,285 * 1.079 = $25,561,471

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 6 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,461,471	$22,351

Based on a $475,000 cost of implementation for CPS, the net value for this SAMA is -$452,649 ($22,351 - $475,000), which indicates this SAMA is not cost-beneficial.

F.6.7 SAMA 7: ENHANCE PROCEDURES AND OPERATOR TRAINING TO INCLUDE CONTAINMENT VENTING CONTROL FOR NPSH MANAGEMENT

For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose net positive suction head (NPSH) and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.

Assumptions:

The procedure improvements and additional training on management of NPSH during containment venting will result in an action reliability that is at comparable to RPV level control during an ATWS event with Feedwater available. The HEP for that action is 3.5E-2 and the HEP for NPSH management during containment venting is assumed to be 5.0E-02 (reduced by an order of magnitude from 5.0E-01).

The probabilities of the dependent action combinations including this HFE are governed mostly by the level of dependence for this late term action and no changes are necessary to the JHEPs.

Note: Different failure probabilities could be proposed/supported for the controlled venting action proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

PRA Model Changes to Model SAMA:

The HEP for the existing action to control containment venting was reduced in the cutsets to reflect the revised procedures and training.

Model Change(s):

The following change was made to the cutset files:

- 1CVOPVENTCTRLH-- (OP FAILS TO CONTROL CONTAINMENT VENT) HEP changed from 5.0E-01 to 5.0E-02.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	**Fire CDF**	**CDF (Total)**	**Dose-Risk (Total)**	**OECR (Total)**
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.83E-06	7.66E-05	7.94E-05	67.34	$951,265
Percent Reduction	2.7%	1.3%	1.3%	1.3%	1.3%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.22E-08	9.00E-07	9.82E-07	1.60E+00	$25,439
ST3 - H/L	5.37E-07	2.59E-05	2.64E-05	4.31E+01	$684,718
ST4 - M/E	1.60E-07	1.90E-05	1.92E-05	1.58E+01	$199,264
ST5 - M/L	3.05E-07	2.11E-05	2.14E-05	5.82E+00	$36,568
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.10E-06	4.00E-07	1.50E-06	2.60E-03	$21
Total	**1.73E-06**	**7.62E-05**	**7.79E-05**	**6.73E+01**	**$951,265**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,317,194. After accounting for “round up” of the base internal events and fire cost-risk, this value is $23,317,306. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23,317,306 * 1.079 = \$25,159,373$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 7 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,159,373	$324,449

Based on a $250,000 cost of implementation for CPS, the net value for this SAMA is $74,449 ($324,449 - $250,000), which indicates this SAMA is potentially cost-beneficial.

F.6.8 SAMA 8: REPLACE THE INBOARD CONTAINMENT VENT AOV WITH AN ENVIRONMENTALLY QUALIFIED VALVE

A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.

Assumptions:

Installation of a re-designed valve will reduce the failure rate of the valve by an order of magnitude.

PRA Model Changes to Model SAMA:

The event representing the failure of the valve to operate due to adverse environmental conditions has been reduced by an order of magnitude.

Note: Different failure probabilities could be proposed/supported for the redesigned containment vent valve proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made to the cutsets:

- 1CVPH-TEMPF—F-- (IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1): Probability changed from 1.0E-02 to 1.0E-03.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.58E-06	7.63E-05	7.89E-05	67.01	$946,628
Percent Reduction	11.3%	1.7%	2.0%	1.7%	1.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST2 - H/E	8.04E-08	9.00E-07	9.80E-07	1.60E+00	$25,392
ST3 - H/L	4.74E-07	2.58E-05	2.63E-05	4.28E+01	$680,497
ST4 - M/E	1.55E-07	1.90E-05	1.92E-05	1.58E+01	$199,212
ST5 - M/L	1.63E-07	2.11E-05	2.12E-05	5.78E+00	$36,326
ST6 - L/E	3.30E-07	2.46E-06	2.79E-06	4.16E-01	$1,908
ST7 - L/L	2.29E-07	2.41E-06	2.64E-06	2.02E-01	$771
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.06E-06	2.00E-07	1.26E-06	2.19E-03	$18
Total	**1.52E-06**	**7.61E-05**	**7.76E-05**	**6.70E+01**	**$946,628**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,198.796. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,198,908. The external events contributions are accounted for by multiplying this value by 1.079:

Total Cost-Risk$_{SAMA}$ = $23,198,908 * 1.079 = $25,031,622

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 8 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,031,622	$452,200

Based on a $1,828,302 cost of implementation for CPS, the net value for this SAMA is -$616,680 ($452,200 - $1,828,302), which indicates this SAMA is not cost-beneficial.

F.6.9 SAMA 9: INSTALL KEYLOCK SWITCH TO OVERRIDE MSIV LOW RPV LEVEL ISOLATION LOGIC

For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level main steam isolation valve (MSIV) isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly.

Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.t.

Assumptions:

The HEP is reduced from 5.72E-1 to 2.04E-02 by modifying the HFE as follows:

- Reduced execution time (Texe) to 1 minute based on simplified keylock switch
- Updated execution steps to reflect switch manipulation rather than installation of jumpers.
- Included generic self-recovery failure probability of 0.1 to each execution step.
- Used the lower bound ASEP time reliability curve to reflect a simple, well understood, and well-trained action.

PRA Model Changes to Model SAMA:

To approximate the impact of this SAMA, the action's HEP was updated to 2.04E-02 and the joint HEPs that include the action were updated with the revised HEP.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.80E-06	7.76E-05	8.04E-05	68.15	$962,881
Percent Reduction	3.8%	0.0%	0.1%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	7.53E-08	9.00E-07	9.75E-07	1.59E+00	$25,260
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	4.37E+01	$695,078
ST4 - M/E	1.32E-07	1.91E-05	1.92E-05	1.58E+01	$200,013
ST5 - M/L	3.05E-07	2.15E-05	2.18E-05	5.93E+00	$37,252
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89

ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.11E-06	5.00E-07	1.61E-06	2.78E-03	$22
Total	**1.69E-06**	**7.71E-05**	**7.88E-05**	**6.82E+01**	**$962,881**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,600,685. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,600,797. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23{,}600{,}797 * 1.079 = \$25{,}465{,}260$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 9 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,465,260	$18,562

Based on a $635,242 cost of implementation for CPS, the net value for this SAMA is -$616,680 ($18,562 - $635,242), which indicates this SAMA is not cost-beneficial.

F.6.10 SAMA 10: INSTALL A HARD PIPED CONNECTION BETWEEN FPS AND RHR

Currently, the Fire Protection System (FPS) can be used to inject to the RPV, but it requires significant manual work to remove the internals of a check valve and time to perform the alignment. The availability of a hard piped, direct connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations.

Assumptions:

While changes to the physical design of the FPS connection will simplify the alignment steps and reduce the time required to perform the action to align FPS for RPV injection, the action will often occur in combination with other operator actions, many of which will be related to RPV inventory control, which likely implies at least a high level of dependence. In addition, the lower quality of water from the FPS and its status would preclude it from being a preferred system such that the alignment would only be directed after the preferred systems are determined to be unavailable. Therefore, while the alignment/execution time would be reduced by this SAMA, the later start to the alignment process relative to "preferred" systems may still lead to timing conditions that would preclude the independent HEP from being low. To address these factors, the failure probability of the event applied to the cutsets will be 0.5.

PRA Model Changes to Model SAMA:

The flag event that representing failure to align the FPS for injection that is currently in the model and set to TRUE has been set to have a failure probability of 0.5.

Note: Different failure probabilities could be proposed/supported for the action to align fire protection for RPV makeup that is proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made to the model:

- FPIE: 1FPOPALIGN-FPH-- (OPERATOR FAILS TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION PER CPS 4411.03): Probability set to 0.5 in the database.
- FIRE: 1FPOPALIGN-FPH-F: (OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION): Probability set to 0.5 in the database.
- Removed both events from FPIE flag file (were set to TRUE).
- In the FPIE recovery file, set the probability to 0.5 (was previously set to 1.0 in the recovery file).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.72E-06	7.39E-05	7.66E-05	65.36	$922,782
Percent Reduction	6.5%	4.8%	4.8%	4.2%	4.2%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	2.39E-08	0.00E+00	2.39E-08	1.26E-01	$1,119
ST2 - H/E	8.13E-08	9.00E-07	9.81E-07	1.60E+00	$25,416
ST3 - H/L	5.17E-07	2.49E-05	2.54E-05	4.14E+01	$658,300
ST4 - M/E	1.60E-07	1.90E-05	1.92E-05	1.58E+01	$199,264
ST5 - M/L	3.15E-07	2.04E-05	2.08E-05	5.65E+00	$35,491
ST6 - L/E	3.29E-07	2.50E-06	2.83E-06	4.22E-01	$1,935
ST7 - L/L	2.19E-07	1.85E-06	2.07E-06	1.58E-01	$604
ST8 - LL/E	2.04E-09	3.20E-07	3.22E-07	2.43E-02	$81
ST9 - LL/L	4.00E-08	3.79E-06	3.83E-06	1.82E-01	$555
ST10 - INTACT	1.03E-06	2.00E-07	1.23E-06	2.13E-03	$17
Total	**1.69E-06**	**7.37E-05**	**7.54E-05**	**6.54E+01**	**$922,782**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $22,610,590. After accounting for “round up” of the base internal events and fire cost-risk, this value is $22,610,702. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$22,610,702 * 1.079 = \$24,396,947$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 10 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$24,396,947	$1,086,875

Based on a $649,194 cost of implementation for CPS, the net value for this SAMA is $437,681 ($1,086,874 - $649,194), which indicates this SAMA is potentially cost-beneficial.

F.6.11 SAMA 11: REPLACE VALVES WITH VERSIONS DESIGNED TO CLOSE AGAINST HIGH FLOW AND DIFFERENTIAL PRESSURE

The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.

Assumptions:

The probability that the new valve will fail to close during an ISLOCA incident is 1E-2. The "new valve" is actually a set of valves that are capable of mitigating each of the ISLOCA sequences in the FPIE model.

There is no impact on the Fire model.

The cost of implementation is a lower bound cost for the CPS SAMA. The implementation cost is based on the installation of two valves; however, in order to achieve the risk reduction resulting from the changes made to model this SAMA, several additional valve replacements would be required. The low averted cost-risk related to this SAMA does not require further refinement of the implementation cost.

PRA Model Changes to Model SAMA:

To represent the impact of the new isolation valves, the ISLOCA sequence tags have been changed from TRUE events to events with a probability of 1.0E-02.

Model Change(s):

The following changes were made to the cutsets:

- RCVSEQ-ISLOCA-002 (ACCIDENT SEQUENCE ISLOCA-002): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-004 (ACCIDENT SEQUENCE ISLOCA-004): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-005 (ACCIDENT SEQUENCE ISLOCA-005): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-006 (ACCIDENT SEQUENCE ISLOCA-006): Event probability changed to 1.0E-02.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.90E-06	7.76E-05	8.05E-05	68.16	$963,087
Percent Reduction	0.3%	0.0%	0.0%	0.1%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.03E-08	0.00E+00	3.03E-08	1.59E-01	$1,418
ST2 - H/E	8.22E-08	9.00E-07	9.82E-07	1.60E+00	$25,439
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	4.37E+01	$695,078
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	5.94E+00	$37,365
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.11E-06	5.00E-07	1.61E-06	2.79E-03	$22
Total	**1.79E-06**	**7.71E-05**	**7.89E-05**	**6.82E+01**	**$963,087**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,607,592. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,607,704. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23,607,704 * 1.079 = \$25,472,713$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 11 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,472,713	$11,109

Based on a $600,000 cost of implementation for CPS, the net value for this SAMA is -$588,891 ($11,109 - $600,000), which indicates this SAMA is not cost-beneficial.

F.6.12 SAMA 12: MODIFY PLANT PROCEDURES TO DIRECT USE OF FLEX GENERATORS TO SUPPORT CONTAINMENT VENTING

The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed at supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power (i.e., the do not isolate when the isolation conditions exist). A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.

Assumptions:

Current FLEX modeling related to repowering the 480V MCCs is applicable to providing power to the buses that support containment venting.

PRA Model Changes to Model SAMA:

To represent the impact of the new isolation valves, the fault tree was changed such that the containment vent paths only fail in SBO scenarios when the alignment of FLEX power to the 480V buses fails.

Model Change(s):

The following changes were made to the fault tree:

- Gate G005: Created a new AND gate above A1AP77EX (gate SAMA-12-1B3) to represent failure of normal and FLEX power to the MCC. Under the AND gate is a new gate (SAMA-12-1B3-FLEX) which includes power from the FLEX DGs, relevant FLEX HFEs, and entry conditions (i.e., SBO required, successful DC load shed, and RCIC short-term).
- Gate Q1FC008: Similar changes as gate G005.
- Gate QGATE113: Similar changes as gate G005.

- Gate QGATE14: Similar changes as gate G005.
- Gate QGATE08: Similar changes as gate G005.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.84E-06	7.64E-05	7.92E-05	66.48	$936,144
Percent Reduction	2.4%	1.5%	1.6%	2.5%	2.8%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.17E-08	9.00E-07	9.82E-07	1.60E+00	$25,426
ST3 - H/L	4.82E-07	2.53E-05	2.58E-05	4.20E+01	$667,754
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	5.94E+00	$37,365
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.10E-06	3.00E-07	1.40E-06	2.42E-03	$19
Total	**1.74E-06**	**7.61E-05**	**7.78E-05**	**6.65E+01**	**$936,144**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $22,997,799. After accounting for “round up” of the base internal events and fire cost-risk, this value is $22,997,911. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$22,997,911 * 1.079 = \$24,814,746$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 12 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$24,814,746	$669,076

Based on a $100,000 cost of implementation for CPS, the net value for this SAMA is $569,076 ($669,076 - $100,000), which indicates this SAMA is potentially cost-beneficial.

F.6.13 SAMA 13: ALTERNATE ECCS PUMP ROOM COOLING

For scenarios involving loss of room cooling to the ECCS pump rooms, perform a room heatup analysis to identify what equipment capabilities would be needed to prevent pump damage on overtemperature given loss of all room cooling (including fans). Provide diverse, portable fan/ductwork that would meet these requirements and maintain room temperature in the acceptable range to allow indefinite operation of the pumps after failure of the normal HVAC system.

Assumptions:

The current, uncredited operator action that models the failure to open doors for alternate RHR and RCIC room cooling (1SYOPROOMCLNGH-*, "OP FAILS TO RECOVER FROM ECCS ROOM COOLING FAILURES ", FPIE HEP = 6.8E-03, Fire HEP = 1.7E-03) can be used to represent the action to establish alternate room cooling for this SAMA, which is conservative in that the SAMA action is a larger scope of steps that potentially includes portable fan and ductwork setup.

The "Intact" release category frequency is assumed to be reduced to zero by this SAMA. The "Intact" frequency is typically calculated by subtracting the total frequency of the Level 2 release category frequencies from the CDF; however, for this SAMA, the total frequency of the Level 2 release category frequencies is larger than the CDF due to model quantification nuances. The "Intact" release category is a negligible contributor to results such that this assumption will not impact any conclusions related to whether the SAMA is potentially cost beneficial or not.

PRA Model Changes to Model SAMA:

The model was changed to allow the operator action 1SYOPROOMCLNGH-* to recovery any room cooling failure that occur for the RHR, RCIC, LPCS, and HPCS pumps.

Model Change(s):

- The following modeling changes were made to the fault tree:
- Gate RHRA-PMP-RMCLG: Replaced gate RHRA-PMPRM-REC with gate HFE-078.
- Gate RHRA-RMCLG: Replaced RHRA-RMCLG-REC with gate HFE-078.
- Gate RHRB-PMP-RMCLG: Replaced gate RHRB-PMPRM-REC with gate HFE-078.
- Gate RHRB-RMCLG: Replaced gate RHRB-RMCLG-REC with gate HFE-078.
- Gate HGATE09: Removed gate DC71P001CX (assume alternate redundant power supply).

The following change was made to the flag file:

- Basic event SYPHRMCLGLIMF-- (RM CLG FAILS DUE TO FLOW LIMITATIONS OR OTHER PHENOM. ISSUES) set to FALSE.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.56E-06	6.98E-05	7.24E-05	61.97	$872,772
Percent Reduction	12.0%	10.1%	10.1%	9.1%	9.4%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.06E-08	8.00E-07	8.81E-07	1.44E+00	$22,808
ST3 - H/L	4.80E-07	2.32E-05	2.37E-05	3.86E+01	$613,312
ST4 - M/E	1.55E-07	1.90E-05	1.92E-05	1.58E+01	$199,212
ST5 - M/L	1.42E-07	1.87E-05	1.88E-05	5.13E+00	$32,220
ST6 - L/E	3.30E-07	2.59E-06	2.92E-06	4.35E-01	$1,997
ST7 - L/L	2.29E-07	2.21E-06	2.44E-06	1.86E-01	$712
ST8 - LL/E	2.20E-09	3.30E-07	3.32E-07	2.51E-02	$84
ST9 - LL/L	4.37E-08	4.07E-06	4.11E-06	1.96E-01	$596

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST10 - INTACT	1.06E-06	0.00E+00	1.06E-06	1.83E-03	$15
Total	**1.50E-06**	**7.09E-05**	**7.24E-05**	**6.20E+01**	**$872,772**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $21,397,534. After accounting for "round up" of the base internal events and fire cost-risk, this value is $21,397,646. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$21,397,646 * 1.079 = \$23,088,060$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 13 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$23,088,060	$2,395,762

Based on a $399,746 cost of implementation for CPS, the net value for this SAMA is $1,996,016 ($2,395,762 - $399,746), which indicates this SAMA is potentially cost-beneficial.

F.6.14 SAMA 14: INSTALL 3-HOUR RATED FIRE CABLE WRAP ON OFFSITE POWER CABLES IN RISK-SIGNIFICANT AREAS

Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the Reserve Auxiliary Transformer (RAT)/Emergency Reserve Auxiliary Transformer (ERAT) feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.

Assumptions:

This SAMA has no significant impact on the FPIE model.

The cable wrap prevents failure of protected cables 100% of the time.

PRA Model Changes to Model SAMA:

The potential for fires on cables related the RAT/ERAT distribution.

Model Change(s):

The following change was made to the FRANX Fire model:

- Removed the "cable to component" relationships from the database for the following components (68 records):
  - 286-B1_1RT4_A_UA
  - 286-BE_1ET4_A_UA
  - 86-RTA_586_A_UA
  - 86-RTC_A_UA

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.91E-06	5.12E-05	5.41E-05	48.02	$702,910
Percent Reduction	0.0%	34.0%	32.8%	29.6%	27.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.22E-08	5.00E-07	5.82E-07	9.49E-01	$15,079
ST3 - H/L	5.37E-07	2.31E-05	2.36E-05	3.85E+01	$612,198
ST4 - M/E	1.62E-07	4.40E-06	4.56E-06	3.75E+00	$47,445
ST5 - M/L	3.71E-07	1.22E-05	1.26E-05	3.42E+00	$21,496
ST6 - L/E	3.30E-07	4.67E-06	5.00E-06	7.45E-01	$3,420
ST7 - L/L	2.29E-07	2.12E-06	2.35E-06	1.79E-01	$686
ST8 - LL/E	2.20E-09	6.00E-07	6.02E-07	4.55E-02	$152
ST9 - LL/L	4.37E-08	4.11E-06	4.15E-06	1.98E-01	$602
ST10 - INTACT	1.11E-06	0.00E+00	1.11E-06	1.93E-03	$15
Total	**1.80E-06**	**5.17E-05**	**5.35E-05**	**4.80E+01**	**$702,910**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of \$16,925,984. After accounting for "round up" of the base internal events and fire cost-risk, this value is \$16,926,096. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$16{,}926{,}096 * 1.079 = \$18{,}263{,}258$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 14 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
\$25,483,822	\$18,263,258	\$7,220,564

Based on a \$5,629,397 cost of implementation for CPS, the net value for this SAMA is \$1,591,167 (\$7,220,564 - \$5,629,397), which indicates this SAMA is potentially cost-beneficial.

F.6.15 SAMA 15: INSTALL A BATTERY BACKUP TO THE HYDROGEN IGNITERS

While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.

Assumptions:

The failure probability of the battery system to provide adequate power to the igniters for the entire mission time is 0.1.

No operator action is needed to power the igniters when normal power is lost.

The supply is available for both SBO and non-SBO scenarios.

PRA Model Changes to Model SAMA:

A lumped event representing the failure of the battery system to supply power to the igniters has been ANDed with the normal supply for the portions of the logic in which it is explicitly modeled and it has been ANDed with the event representing the presence of a random ignition source for the portions of the logic in which it has already been established that the normal power supply is not available.

Model Change(s):

The following modeling changes were made to the fault tree:

- Gate CGATE104: Created a new AND gate (SAMA-15-1) above gate A1AP72EX. A new basic event (F_SAMA_15) is included in the new AND gate to model failure of the new AC power source.
- Gate CGATE105: Created a new AND gate (SAMA-15-2) above gate A1AP75EX. A new basic event (F_SAMA_15) is included in the new AND gate to model failure of the new AC power source.
- Gate CZ-DW-DEFLAG-SBO: Created a new AND gate (SAMA-15-SBO). Added events 1HIPH-H2IGSBOF--and F_SAMA_15 to SAMA-15-SBO. Deleted 1HIPH-H2IGSBOF-- from under CZ-DW-DEFLAG-SBO.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.91E-06	7.76E-05	8.05E-05	66.97	$947,480
Percent Reduction	0.0%	0.0%	0.0%	1.8%	1.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	4.29E-08	8.28E-07	8.71E-07	1.42E+00	$22,569
ST3 - H/L	4.84E-07	2.62E-05	2.67E-05	4.35E+01	$691,126
ST4 - M/E	1.61E-07	1.83E-05	1.85E-05	1.52E+01	$191,950
ST5 - M/L	3.71E-07	2.11E-05	2.14E-05	5.83E+00	$36,672
ST6 - L/E	3.17E-07	2.51E-06	2.83E-06	4.22E-01	$1,936
ST7 - L/L	2.02E-07	2.12E-06	2.32E-06	1.77E-01	$678
ST8 - LL/E	2.20E-09	3.55E-07	3.57E-07	2.70E-02	$90
ST9 - LL/L	4.37E-08	4.07E-06	4.11E-06	1.96E-01	$596
ST10 - INTACT	1.25E-06	2.14E-06	3.39E-06	5.86E-03	$47
Total	**1.66E-06**	**7.55E-05**	**7.71E-05**	**6.70E+01**	**$947,480**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of \$23,253,238. After accounting for "round up" of the base internal events and fire cost-risk, this value is \$23,253,350. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23,253,350 * 1.079 = \$25,090,365$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 15 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
\$25,483,822	\$25,090,365	\$393,457

Based on a \$352,000 cost of implementation for CPS, the net value for this SAMA is \$41,457 (\$393,457 - \$352,000), which indicates this SAMA is potentially cost-beneficial.

F.6.16 SAMA 16 SQUIB VALVE BYPASS LINE

Failure of the explosive valves in the SLC injection pathway (squib valves) leads to loss of the ability inject liquid poison in the reactor in a timely manner. Providing a bypass line that includes MOVs would provide a diverse injection pathway.

Assumptions:

The bypass line provides a functionally equivalent means of injecting SLC into the RPV such that if the SQUIB valves fail, the bypass line can be used in the same way to inject SLC.

The bypass line is modeled with a lumped event that has a failure probability of 0.1, which represents hardware failure, support system failure, and any operator actions/dependencies that would be relevant to its use (e.g., the diagnosis of the failure of the squib valves and the need to use the bypass line).

PRA Model Changes to Model SAMA:

The fault tree was updated to credit the fire protection system in the places where LPCI and LPCS are credited, but the system is failed for the LOCA and IORV initiating event and for water hammer scenarios. In addition, the logic was changed to include the fire protection system injection capability in the early SBO scenarios in which ADS is available for those sequences do not impact by the LPCS-LPCI gate.

Model Change(s):

The following changes were made to the fault tree:

- Gate SGATE01: Created a new AND gate (SAMA-16) above gate SGATE02. A new basic event (F_SAMA_16) is included in the new AND gate to model failure of the new bypass line.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,428
Percent Reduction	0.0%	0.0%	0.0%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.12E-08	9.00E-07	9.81E-07	1.60E+00	$25,413
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	4.37E+01	$695,078
ST4 - M/E	1.59E-07	1.91E-05	1.93E-05	1.59E+01	$200,294
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	5.94E+00	$37,365
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.12E-06	5.00E-07	1.62E-06	2.80E-03	$22
Total	**1.79E-06**	**7.71E-05**	**7.89E-05**	**6.82E+01**	**$963,428**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,617,030. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,617,142. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$23{,}617{,}142 * 1.079 = \$25{,}482{,}896$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 16 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,482,896	$926

Based on a $716,477 cost of implementation for CPS, the net value for this SAMA is -$715,551 ($926 - $716,477), which indicates this SAMA is not cost-beneficial.

F.6.17 SAMA 17: PROTECT THE EQUIPMENT REQUIRED FOR SRV OPERATION IN THE AUX. BUILDING

In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.

Assumptions:

The SAMA will prevent all environmentally induces failures of the safety relief valves (SRVs).

PRA Model Changes to Model SAMA:

The flag file was used to set the events related to adverse environmental conditions to FALSE.

Model Change(s):

The following events were set to FALSE in the flag files:

- 1OPPH-EN-CLIVF–(ADVERSE AUX BUILDING ENVIRON. CONDITIONS AFFECT SRVs (ATWS))
- 1OPPH-RX-ENVIF–(ADVERSE AUX BLDG ENVIRON CONDITIONS CAUSE FAILURE)
- 1OPPH-CNTFAD-F–(STRUCTURAL BREACH IN CONT. CUASES FAILURE OF ADS)

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.91E-06	7.76E-05	8.05E-05	67.99	$960,364
Percent Reduction	0.0%	0.0%	0.0%	0.3%	0.3%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 – H/E	7.76E-08	9.00E-07	9.78E-07	1.59E+00	$25,320
ST3 – H/L	5.36E-07	2.62E-05	2.67E-05	4.36E+01	$692,462
ST4 – M/E	1.42E-07	1.91E-05	1.92E-05	1.58E+01	$200,117
ST5 – M/L	3.65E-07	2.14E-05	2.17E-05	5.91E+00	$37,184
ST6 – L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 – L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 – LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 – LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 – INTACT	1.15E-06	7.00E-07	1.85E-06	3.19E-03	$26
Total	**1.76E-06**	**7.69E-05**	**7.87E-05**	**6.80E+01**	**$960,364**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,549,789. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,549,901. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23{,}549.901 * 1.079 = \$25{,}410{,}343$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 17 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,410,343	$73,479

Based on a $701,000 cost of implementation for CPS, the net value for this SAMA is -$627,521 ($73,479 - $701,000), which indicates this SAMA is not cost-beneficial.

F.6.18 SAMA 18 INSTALL AN EMERGENCY RCIC STORAGE TANK MAKEUP CAPABILITY FROM SERVICE WATER OPERABLE FROM THE MCR

For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a RCIC Storage Tank makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.

Assumptions:

It is assumed that the plant service water system (WS) is the source of the makeup water to the RCIC storage tank.

It is assumed that the failure probability for this SAMA can be represented by a lumped event with a failure probability of 0.25 that addresses failure of the operators to align the makeup source (including the impacts of dependencies), hardware failures of the makeup line, and support systems dependencies.

PRA Model Changes to Model SAMA:

The assumption that the inventory in the RCIC storage tank in inadequate for the mission time has been set to FALSE. A lumped event representing the ability to provide adequate makeup water to the RCIC storage tank has been added and a failure probability of 0.25 is used, which is appliable in scenarios that require use of the RCIC storage tank for a suction source, including ISLOCA/BOC.

Note: Different failure probabilities could be proposed/supported for the RCIC storage tank makeup function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following changes were made in the fault tree:

- Gate HGATE25: Included a new surrogate basic event (F_SAMA_18) for RCIC tank makeup using WS. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate UGATE23: Included a new surrogate basic event (F_SAMA_18) for RCIC tank makeup using WS. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate XT-CRD: Included existing gate YU1-XZ under it, which allows HPCS with RCIC tank makeup alone to mitigate ISLOCA/BOC/LLOCA sequences and not require other external sources.

The following changes have been made to the flag file:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.82E-06	7.73E-05	8.01E-05	68.04	$961,870
Percent Reduction	3.1%	0.4%	0.5%	0.2%	0.2%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.91E-10	0.00E+00	4.91E-10	2.58E-03	$23
ST2 - H/E	8.22E-08	8.93E-07	9.75E-07	1.59E+00	$25,259
ST3 - H/L	5.37E-07	2.63E-05	2.69E-05	4.38E+01	$695,540
ST4 - M/E	1.62E-07	1.91E-05	1.92E-05	1.58E+01	$199,981
ST5 - M/L	3.71E-07	2.15E-05	2.18E-05	5.94E+00	$37,340
ST6 - L/E	3.29E-07	2.58E-06	2.91E-06	4.34E-01	$1,991

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST7 - L/L	2.27E-07	4.21E-06	4.44E-06	3.39E-01	$1,295
ST8 - LL/E	2.18E-07	1.99E-07	4.17E-07	3.15E-02	$105
ST9 - LL/L	4.20E-08	2.15E-06	2.20E-06	1.05E-01	$318
ST10 - INTACT	8.51E-07	4.14E-07	1.26E-06	2.19E-03	$18
Total	**1.97E-06**	**7.69E-05**	**7.89E-05**	**6.80E+01**	**$961,870**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,566,553. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,566,665. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$23{,}566{,}665 * 1.079 = \$25{,}428{,}432$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 18 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,428,432	$55,390

Based on a $2,900,000 cost of implementation for CPS, the net value for this SAMA is -$2,844,610 ($55,390 - $2,900,000), which indicates this SAMA is not cost-beneficial.

F.6.19 SAMA 19 MODIFY FLEX PROCEDURE FOR FPS MAKEUP TO THE RCIC STORAGE TANK TO ALLOW USE IN NON-ELAP SCENARIOS

For cases in which suppression pool (SP) cooling is not available, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RCIC injection for a longer time without SPC.

Assumptions:

The assumption that the inventory in the RCIC storage tank in inadequate for the mission time has been set to FALSE. A lumped event representing the ability to provide adequate makeup water to the RCIC storage tank has been added and a failure probability of 0.25 is used, which is appliable in scenarios that require use of the RCIC storage tank for a suction source.

ISLOCA/BOC events are not assumed to be mitigated due to limited flow from the FPS system to the RCIC storage tank.

Note: Different failure probabilities could be proposed/supported for the RCIC storage tank makeup function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

PRA Model Changes to Model SAMA:

The following changes were made in the fault tree:

- Gate HGATE25: Included a new surrogate basic event (F_SAMA_19) for RCIC tank makeup using FP. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate UGATE23: Included a new surrogate basic event (F_SAMA_19) for RCIC tank makeup using FP. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- ISLOCA Event Tree: Renamed gate YU1-X in the ISLOCA sequences (gates ISLOCA-*) to YU1-X-I. Gate YU1-X-I does not credit the RCIC tank (see gate HGATE61-I for the gate where RCIC tank logic was removed).

The following changes have been made to the flag file:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.86E-06	7.73E-05	8.02E-05	68.18	$963,379
Percent Reduction	1.7%	0.4%	0.4%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.22E-08	9.00E-07	9.82E-07	1.60E+00	$25,439
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	4.37E+01	$695,078
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325
ST5 - M/L	3.71E-07	2.15E-05	2.18E-05	5.94E+00	$37,331
ST6 - L/E	3.29E-07	2.58E-06	2.91E-06	4.33E-01	$1,990
ST7 - L/L	2.27E-07	2.19E-06	2.42E-06	1.85E-01	$706
ST8 - LL/E	2.18E-09	3.20E-07	3.22E-07	2.44E-02	$81
ST9 - LL/L	4.20E-08	4.05E-06	4.09E-06	1.95E-01	$593
ST10 - INTACT	1.07E-06	4.00E-07	1.47E-06	2.54E-03	$20
Total	**1.79E-06**	**7.69E-05**	**7.87E-05**	**6.82E+01**	**$963,379**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,604,474. After accounting for "round up" of the base internal events and fire cost-risk, this value is $23,604.586. The external events contributions are accounted for by multiplying this value by 1.079:

Total Cost-Risk$_{SAMA}$ = $23,604,586 * 1.079 = $25,469,348

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 19 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,469,348	$14,474

Based on a $100,000 cost of implementation for CPS, the net value for this SAMA is -$85,526 ($14,474 - $100,000), which indicates this SAMA is not cost-beneficial.

F.6.20 SAMA 20 ADDITIONAL DIESEL GENERATOR THAT CAN ACT AS A SWING DIESEL GENERATOR TO ALL DIVISIONS OF AC POWER

Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.

Assumptions:

This SAMA is modeled with a surrogate event that represents the new swing diesel generator. A value of 0.25 was selected as bounding for all failure modes (including operator actions to start the swing diesel generator).

The SAMA diesel generator can power multiple divisions simultaneously.

PRA Model Changes to Model SAMA:

The model was updated to AND the surrogate event with the logic representing existing EDGs 1A, 1B, and 1C such that it can provide power to the same loads when the current EDGs fail.

Note: Different failure probabilities could be proposed/supported for the swing EDG proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made in the fault tree:

- Added a new surrogate basic event (F_SAMA_20) to the following gates:
  - A1ASUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1A1 (1AP07E))
  - ALASUPPORT-D3 (LOSS OF SUPPORT SYSTEMS FOR BUS 1A1 (1AP07E))
  - A1AP07EX-NO-D3 (NO POWER TO 4KV BUS 1A1 (1AP07E) (NO CREDIT FOR DIV 3 DG XTIE))
  - 1B1SUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1B1 (1AP09E))
  - S004SUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1C1 (1E22-S004))

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	1.80E-06	5.52E-05	5.70E-05	46.72	$674,894
Percent Reduction	38.1%	28.9%	29.2%	31.5%	30.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	4.69E-08	8.00E-07	8.47E-07	1.38E+00	$21,935
ST3 - H/L	1.91E-07	2.16E-05	2.18E-05	3.55E+01	$564,387
ST4 - M/E	1.37E-07	5.20E-06	5.34E-06	4.39E+00	$55,505
ST5 - M/L	3.69E-07	1.62E-05	1.66E-05	4.51E+00	$28,333
ST6 - L/E	6.95E-08	2.48E-06	2.55E-06	3.80E-01	$1,744
ST7 - L/L	1.01E-07	1.56E-06	1.66E-06	1.27E-01	$485
ST8 - LL/E	2.18E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.15E-08	3.71E-06	3.75E-06	1.79E-01	$544
ST10 - INTACT	8.03E-07	3.30E-06	4.10E-06	7.10E-03	$57
Total	**9.97E-07**	**5.19E-05**	**5.29E-05**	**4.67E+01**	**$674,894**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $16,454,589. After accounting for "round up" of the base internal events and fire cost-risk, this value is $16,454,701. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$16,454,701 * 1.079 = \$17,754,622$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 20 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$17,754,622	$7,729,200

Based on a $8,000,000 cost of implementation for CPS, the net value for this SAMA is -$270,800 ($7,729,200 - $8,000,000), which indicates this SAMA is not cost-beneficial.

F.6.21 SAMA 21 ADDRESS FLOW FW DIVERSION IN THE LOSS OF INSTRUMENT AIR PROCEDURE

Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.

Assumptions:

Loss of Instrument Air is no longer assumed to lead to loss of feedwater, or to a flow diversion that fails feedwater flow.

PRA Model Changes to Model SAMA:

The failure of instrument air logic has been removed from the FW flow diversion gate and as a cause of Loss of Feedwater.

Model Change(s):

The following change was made to the fault tree:

- Gate JGATE01 (INSTRUMENT AIR UNAVAILABLE TO TURB BLDG HEADER OR CONTAINMENT/DRYWELL): Removed from gate FGATE99 (SUPPORT SYSTEM FAILURES CAUSE FLOW DIVERSION).
- Gate FGATEIIAI (LOSS OF INSTRUMENT AIR INITIATOR OR FLOODS W/ SAME IMPACT): Removed from gate FW-INITIATORS (INITIATORS THAT CAUSE LOSS OF FW).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)

Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
Percent Reduction	0.0%	0.0%	0.0%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.22E-08	9.00E-07	9.82E-07	1.60E+00	$25,439
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	4.37E+01	$695,078
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	5.94E+00	$37,365
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	1.88E-01	$718
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	2.66E-02	$89
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	1.97E-01	$601
ST10 - INTACT	1.11E-06	5.00E-07	1.61E-06	2.79E-03	$22
Total	**1.80E-06**	**7.71E-05**	**7.89E-05**	**6.82E+01**	**$963,485**

Applying the process described in Section F.4 yields an internal events cost-risk of $23,617,888. After accounting for “round up” of the base internal events and fire cost-risk, this value is $23,618,000. The external events contributions are accounted for by multiplying this value by 1.079:

$$\text{Total Cost-Risk}_{SAMA} = \$23,618,000 * 1.079 = \$25,483,822$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 21 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,483,822	$0

Based on a $30,000 cost of implementation for CPS, the net value for this SAMA is -$30,000 ($0 - $30,000), which indicates this SAMA is not cost-beneficial.

F.6.22 SAMA 22 UPGRADE THE ALTERNATE SHUTDOWN PANEL TO INCLUDE ADDITIONAL SYSTEM CONTROL FOR THE OPPOSITE DIVISION

The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.

Assumptions:

The availability of an additional division of system controls provides diversity in hardware availability, but complete dependence is assumed between operator actions performed on the two divisions of equipment controls.

PRA Model Changes to Model SAMA:

The failure probability of the lumped event representing safe shutdown of the plant after MCR evacuation has been changed from 0.1 to 0.05 for non-fire scenarios.

For Fire scenarios, the failure of the “A” train of RHR has been combined with a new event representing the “B” equipment division, which has a failure probability of 0.1. This does not include operator actions, which are addressed by a separate event, and the operation of the second division is assumed to be completely dependent on the first such that the HEPs do not need to be reduced.

Note: Different failure probabilities could be proposed/supported for the event representing safe shutdown of the plant outside the main control room and/or for the additional train of equipment proposed in this SAMA; however, further reducing the failure probabilities will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following changes were made to FPIE model:

- Reduced probability for 1XXPH-FLRSPRQH-- (FAILURE TO SHUTDOWN PLANT USING REMOTE SHUTDOWN PANEL) from 0.1 to 0.05 based on the ability to utilize additional divisions of equipment.

The following changes were made to Fire model:

- Gate RSDP-SPC-A (CONTROL OF RHR A FROM THE RSDP FAILS): Created a new AND gate (SAMA-22-SPC) above gate R1SPCX-RSDP (NO TRAIN A SUPP POOL COOLING (RSDP)). Under this new AND gate, a new surrogate event (F_SAMA_22) with a value of 0.1 is included to reflect the additional divisions of equipment that would be available. The existing operator actions for controlling systems from the RSDP remain unchanged and will fail the RSDP function as the action is independent of the division of equipment being operated.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05	68.20	$963,485
SAMA Value	2.61E-06	7.62E-05	7.88E-05	67.59	$956,360
Percent Reduction	10.3%	1.8%	2.1%	0.9%	0.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	2.04E-01	$1,816
ST2 - H/E	8.08E-08	9.00E-07	9.81E-07	1.60E+00	$25,403
ST3 - H/L	5.30E-07	2.61E-05	2.66E-05	4.34E+01	$689,717
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	1.59E+01	$200,325
ST5 - M/L	3.71E-07	2.05E-05	2.09E-05	5.67E+00	$35,655
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	4.43E-01	$2,031
ST7 - L/L	2.01E-07	2.23E-06	2.43E-06	1.86E-01	$710
ST8 - LL/E	1.35E-09	3.50E-07	3.51E-07	2.66E-02	$89
ST9 - LL/L	2.82E-08	4.10E-06	4.13E-06	1.97E-01	$599
ST10 - INTACT	8.67E-07	3.00E-07	1.17E-06	2.02E-03	$16
Total	**1.74E-06**	**7.59E-05**	**7.76E-05**	**6.76E+01**	**$956,360**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $23,401,642. After accounting for “round up” of the base internal events and fire cost-risk, this value is $23,401,754. The external events contributions are accounted for by multiplying this value by 1.079:

Total Cost-Risk$_{SAMA}$ = \$23,401,754 * 1.079 = \$25,250,493

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 22 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$25,483,822	$25,250,493	$233,329

Based on a $790,000 cost of implementation for CPS, the net value for this SAMA is -$556,671 ($233,329 - $790,000), which indicates this SAMA is not cost-beneficial.

F.7 SENSITIVITY ANALYSIS

NEI 05-01 recommends that applicants perform sensitivity analyses that evaluate how changes to certain assumptions and uncertainties in the SAMA analysis would affect the cost-benefit analysis outcome. Accordingly, the following uncertainties were further investigated as to their impact on the overall SAMA evaluation:

- Use of a discount rate of 7 percent, instead of 3 percent used in the base case analysis.
- Use of the 95th percentile PRA results in place of the point estimate PRA results.
- Variations in selected WinMACCS input variables.
- Inclusion of the reliable hard pipe vent on potentially cost-beneficial SAMAs

F.7.1 REAL DISCOUNT RATE

The RDR is an estimate of the rate of return on invested dollars above the rate of inflation. A scenario with a low RDR would require a larger investment of present day dollars to pay for a future expense than a scenario with a relatively high RDR. In a SAMA analysis, large RDRs reduce the averted cost-risk values associated with SAMA implementation relative to low RDRs because the present day dollar investment to pay for accident mitigation would be less.

The baseline SAMA analysis uses an RDR of 3 percent, which could be viewed as conservative given that NUREG/BR-0184 suggests the use of an RDR of 7 percent (NRC 1997). In this sensitivity case, the Phase 1 and Phase 2 results were re-evaluated using the 7 percent RDR suggested in NUREG/BR-0184.

For the Phase 1 analysis, the MACR was recalculated using the methodology outlined in Section F.4, and the SAMA implementation costs were compared to the revised MACR. Based on the reduction of the MACR to $18,415,293 (a 28 percent reduction of the baseline MACR), no additional SAMAs would be screened out in the Phase 1 analysis due to the use of the 7 percent RDR.

For the Phase 2 analysis, the determination of cost effectiveness changed for three of the Phase 2 SAMAs when the 7 percent RDR was used in lieu of 3 percent, as shown below.

Summary of the Impact of the RDR Value on the Detailed SAMA Analyses

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (3 percent RDR)	Net Value (3 percent RDR)	Averted Cost Risk (7 percent RDR)	Net Value (7 percent RDR)	Change in Cost Effective-ness?
SAMA 1	$399,746	$161,082	-$238,664	$116,734	-$283,012	No
SAMA 2	$50,000	$1,789,419	$1,739,419	$1,291,887	$1,241,887	No
SAMA 3	$8,915,554	$122,154	-$8,793,400	$95,350	-$8,820,204	No
SAMA 4	$12,940,000	$8,324,631	-$4,615,369	$5,990,352	-$6,949,648	No
SAMA 5	$400,000	$335,407	-$64,593	$242,637	-$157,363	No
SAMA 6	$475,000	$22,351	-$452,649	$17,035	-$457,965	No
SAMA 7	$250,000	$324,449	$74,449	$234,574	-$15,426	Yes
SAMA 8	$1,828,302	$452,200	-$1,376,102	$327,213	-$1,501,089	No
SAMA 9	$635,242	$18,562	-$616,680	$13,527	-$621,715	No
SAMA 10	$649,194	$1,086,875	$437,681	$786,402	$137,208	No
SAMA 11	$600,000	$11,109	-$588,891	$7,974	-$592,026	No
SAMA 12	$100,000	$669,076	$569,076	$481,620	$381,620	No
SAMA 13	$399,746	$2,395,762	$1,996,016	$1,732,501	$1,332,755	No
SAMA 14	$5,629,397	$7,220,564	$1,591,167	$5,225,625	-$403,772	Yes
SAMA 15	$352,000	$393,457	$41,457	$281,573	-$70,427	Yes
SAMA 16	$716,477	$926	-$715,551	$661	-$715,816	No
SAMA 17	$701,000	$73,479	-$627,521	$52,585	-$648,415	No
SAMA 18	$2,900,000	$55,390	-$2,844,610	$40,502	-$2,859,498	No
SAMA 19	$100,000	$14,474	-$85,526	$11,132	-$88,868	No
SAMA 20	$8,000,000	$7,729,200	-$270,800	$5,583,239	-$2,416,761	No
SAMA 21	$30,000	$0	-$30,000	$0	-$30,000	No
SAMA 22	$790,000	$233,329	-$556,671	$170,733	-$619,267	No

F.7.2 95TH PERCENTILE PRA RESULTS

The results of the SAMA analysis can be impacted by implementing conservative values from the PRA's uncertainty distribution. If the best estimate failure probability values were consistently lower than the "actual" failure probabilities, the PRA model would underestimate plant risk and yield lower than "actual" averted cost-risk values for potential SAMAs. Re-assessing the cost-benefit calculations using the high end of the failure probability distributions is a means of identifying the impact of having consistently underestimated failure probabilities for plant equipment and operator actions included in the PRA model. This sensitivity uses the 95th percentile results to examine the impact of uncertainty in the PRA model.

In performing the sensitivity analysis, only the base case was used in determining the appropriate value for the 95th percentile. For those SAMAs that required the addition of new basic events, no new uncertainty distributions were assigned since the design and implementation of each SAMA was arbitrary and was defined by the analysis assumptions. The results of this uncertainty analysis, therefore, show the expected statistical uncertainty of the CDF risk metrics under the assumption that each SAMA was designed and implemented as it was specified in this analysis. All calculations were performed using version 4.0 of the EPRI Uncert software package for the CPS model.

Because both the fire model and the FPIE model were directly used in the CPS SAMA quantifications, it was necessary to determine how to reflect the impact of the 95th percentile results of each model on the SAMA quantifications. The approach chosen was to use the larger ratio of the 95th percentile CDF to the point estimate CDF from the FPIE and fire models to represent the results for both models. For CPS, the larger ratio is based on the Fire model results.

The results of the uncertainty calculation show that the 95th percentile fire CDF is 1.90E-04, which is a factor of 2.45 greater than the CPS CL117BF0 model CDF point estimate of 7.75E-05. Therefore, for this analysis, the 95th percentile multiplier derived from the base case is used to examine the change in the cost benefit for each SAMA.

F.7.2.1 PHASE 1 IMPACT

For Phase 1 screening, use of the 95th percentile PRA results will increase the MACR and may prevent the screening of some of the higher cost modifications. However, the impact on the overall SAMA results due to the retention of the higher cost SAMAs for Phase 2 analysis is typically small. This is due to the fact that the benefit obtained from the implementation of those SAMAs must be extremely large in order to be cost-beneficial.

The impact of uncertainty in the PRA results on the Phase 1 SAMA analysis has been examined. The MACR is the primary Phase 1 criterion affected by PRA uncertainty. Thus, this portion of the sensitivity is focused on recalculating the MACR using the 95th percentile PRA results and re-performing the Phase 1 screening process. As discussed above, the 95th PRA results are a factor of 2.45 greater than the point estimate CDF.

In order to simulate the use of the 95th percentile PRA results on the cost benefit calculations, the same scaling factor calculated for the Level 1 results was assumed to apply to the Level 3 results. Because the MACR calculations scale linearly with the CDF, dose-risk, and off-site economic cost-risk, the 95th percentile MACR can be calculated by multiplying the base case MACR by 2.45. This results in a 95th percentile MACR of $62,435,364.

The initial SAMA list has been re-examined using the revised MACR to identify SAMAs that would have been retained for the Phase 2 analysis. Those SAMAs that were previously screened out due to costs of implementation that exceeded $25,483,822 are now retained if the costs of implementation are less than $62,435,364. For CPS, no SAMA were screened out on cost in Phase 1; therefore, the increase in the MACR to the 95th percentile value has no impact on the Phase 1 screening process.

F.7.2.2 PHASE 2 IMPACT

As discussed above, a single factor based on the 95th percentile CDF value from the baseline fire model is used to determine the impact of the cost-benefit analysis for the proposed SAMA candidates. The uncertainty analyses that are available for the Level 1 model are not available (or not used) for the full spectrum of Level 2 release categories or the Level 3 models. In order to simulate the use of the 95th percentile results for the Level 2 and 3 models, the same scaling factor calculated for the Level 1 results was implicitly applied to the dose-risk and offsite economic cost-risk through the application of the multiplier to the base case averted cost-risk values.

The Phase 2 SAMA list was re-examined by multiplying the nominal averted cost-risk by the ratio of the 95th percentile CDF to the point estimate CDF value (see Section 7.2) to identify SAMAs that would be re-characterized as potentially cost-beneficial, i.e., positive net value. Those SAMAs that were previously determined to be not cost-beneficial due to implementation costs exceeding their associated nominal averted cost risk values may be potentially cost-beneficial at the revised 95th percentile averted cost risk. In this case, three additional Phase 2 SAMAs become potentially cost-beneficial (SAMAs 4, 5, and 20).

F.7.2.3 95TH PERCENTILE SUMMARY

The following table provides a summary of the impact of using the 95th percentile PRA results on the detailed cost-benefit calculations that have been performed.

Summary of the Impact of Using the 95th Percentile PRA Results

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (Base)	Net Value (Base)	Averted Cost Risk (95th Percentile)	Net Value (95th Percentile)	Change in Cost Effective-ness?
SAMA 1	$399,746	$161,082	-$238,664	$394,651	-$5,095	No
SAMA 2	$50,000	$1,789,419	$1,739,419	$4,384,077	$4,334,077	No
SAMA 3	$8,915,554	$122,154	-$8,793,400	$299,277	-$8,616,277	No
SAMA 4	$12,940,000	$8,324,631	-$4,615,369	$20,395,346	$7,455,346	Yes
SAMA 5	$400,000	$335,407	-$64,593	$821,747	$421,747	Yes
SAMA 6	$475,000	$22,351	-$452,649	$54,760	-$420,240	No
SAMA 7	$250,000	$324,449	$74,449	$794,900	$544,900	No
SAMA 8	$1,828,302	$452,200	-$1,376,102	$1,107,890	-$720,412	No
SAMA 9	$635,242	$18,562	-$616,680	$45,477	-$589,765	No
SAMA 10	$649,194	$1,086,875	$437,681	$2,662,844	$2,013,650	No
SAMA 11	$600,000	$11,109	-$588,891	$27,217	-$572,783	No
SAMA 12	$100,000	$669,076	$569,076	$1,639,236	$1,539,236	No
SAMA 13	$399,746	$2,395,762	$1,996,016	$5,869,617	$5,469,871	No
SAMA 14	$5,629,397	$7,220,564	$1,591,167	$17,690,382	$12,060,985	No
SAMA 15	$352,000	$393,457	$41,457	$963,970	$611,970	No
SAMA 16	$716,477	$926	-$715,551	$2,269	-$714,208	No
SAMA 17	$701,000	$73,479	-$627,521	$180,024	-$520,976	No
SAMA 18	$2,900,000	$55,390	-$2,844,610	$135,706	-$2,764,295	No
SAMA 19	$100,000	$14,474	-$85,526	$35,461	-$64,539	No
SAMA 20	$8,000,000	$7,729,200	-$270,800	$18,936,540	$10,936,540	Yes
SAMA 21	$30,000	$0	-$30,000	$0	-$30,000	No
SAMA 22	$790,000	$233,329	-$556,671	$571,656	-$218,344	No

When the 95th percentile PRA results were applied to the Phase 1 analysis, the increase in the MACR did not impact the screening results because none of the SAMAs had been screened out on implementation cost even using the baseline results.

When the 95th percentile PRA results were applied to the Phase 2 analysis, three SAMAs (4, 5, and 20) that were previously classified as not cost-effective were determined to be potentially cost-effective. The use of the 95th percentile PRA results is not considered to provide the best assessment of the cost-effectiveness of a SAMA. Instead, it is intended to address the uncertainties inherent in the SAMA analysis. Nonetheless, these additional SAMAs identified as potentially cost-beneficial through this sensitivity case (none of which is related to aging management under 10 C.F.R. Part 54) should be further evaluated for possible implementation using current, applicable plant procedures.

F.7.3 WINMACCS INPUT VARIATIONS

The WinMACCS model was developed using the best information available for the CPS site; however, reasonable changes to modeling assumptions can lead to variations in the Level 3 PRA results. In order to determine how certain assumptions could impact the SAMA results, a sensitivity analysis was performed on parameters that have previously been shown to impact the Level 3 results. These parameters include:

- Meteorological data
- Evacuation timing and speed
- Release height and heat
- Deposition velocity
- Population estimates
- Population resettlement planning
- Decontamination Costs & Time
- Economic rate of return
- Ingestion dose

The risk metrics produced by WinMACCS that are evaluated in the sensitivity analyses are the 50-mile population dose risk and the 50 mile offsite economic cost risk. The subsections below discuss the changes in these results for each of the sensitivity parameters noted above. The final subsection, F.7.3.10, correlates the worst case changes identified in the sensitivity runs to a change in the site's averted cost-risk and discusses the implications of the sensitivity analysis on the SAMA analysis. The results of the individual sensitivity cases are summarized in the following table.

Sensitivity of CPS Baseline Risk to Model Changes

Model Change	Description	Pop. Dose Risk Δ Base (%)	Cost Risk Δ Base (%)
Meteorology Data Set	Year 2019 Meteorology (Base case is 2020)	-0.64%	-0.1%
	Year 2021 Meteorology	-0.0%	+0.2%
Weather Distribution	Weather variability median (50th %) results. (Base case is 2020 mean results)	-16%	-19%
	Weather variability 95th % results.	+74%	+120%
	Weather variability 5th % results.	-62%	-72%
Evacuation Delay	Evacuation delay increased; Cohort 1: x2 to 114 min, Cohort 2: x1.5 to 157.5 min (Base case is 57 min & 105 min.)	+0.1%	0.0%
Evacuation Slower	Evacuation speed halved; Cohort 1: 2 m/s, Cohort 2: 1.2 m/s. (Base case is 4 m/s and 2.4 m/s.)	+0.2%	0.0%
Evacuate Faster	Evacuation speed doubled; Cohort 1: 8 m/s, Cohort 2: 4.8 m/s. (Base case is 4 m/s and 2.4 m/s.)	-0.1%	0.0%
Release Height	Release height set to ground level (Base case is Containment mid-height of, 29.1 m).	+0.2%	-1.4%
	Release height set to top of Containment, 58.2 m	-0.2%	+1.5%
Release Heat	No buoyant plume assumed (0 watts for each plume segment).	+0.3%	-1.9%
Deposition Velocity	Single dry deposition velocity of 0.3 cm/sec. (Base case is WinMACCS 10 bin distribution.)	+6.6%	+16%
Population	Population increased uniformly 30% to 1,094,275. (Base case population is 841,744.)	+25%	+23%
Resettlement Planning	No "Intermediate Phase" resettlement planning (Base case is 6 months)	+13%	-43%

Sensitivity of CPS Baseline Risk to Model Changes

Model Change	Description	Pop. Dose Risk Δ Base (%)	Cost Risk Δ Base (%)
	1 year "Intermediate Phase" resettlement planning	-11%	+40%
Decontamination Costs & Time	Non-farm decon (DRF=15) time and cost at maximum. (Base case is SOARCA CPI based).	-0.1%	+18%
Rate of Return	3% expected rate of return (Base case is 7%)	+0.3%	-10%
	12% expected rate of return	-0.3%	+11%
Ingestion Dose	Ingestion dose (food and water) is excluded. (Base case includes ingestion dose.)	-16%	0%

F.7.3.1 METEOROLOGICAL SENSITIVITIES

In addition to the year 2020 base case meteorological data, years 2019 and 2021 were also analyzed. The differences in dose risk and cost risk results between data sets is small (<1%) as generally expected based on past analyses and the use of all weather sequences (i.e., 8760 hourly readings) rather than use of a sampling approach. In accordance with NEI 05-01 (NEI 2005), these sensitivities demonstrate that the year 2020 meteorological data used for the base case is representative. The 2020 data set was selected for the base case based on the combination of low data voids and generally higher dose risk and cost risk results compared to the other data sets.

For many metrics WinMACCS can provide a distribution of the results on the basis of weather variability. The distribution results associated with the base case year (2020) for the SAMA metrics of population dose risk and cost risk are presented for the median (50^{th} percentile), the 95^{th} percentile, and the 5^{th} percentile. The weather variability cases demonstrate that the median 50^{th} percentile results are below the mean results by approximately 16% and 19% for dose risk and cost risk, respectively. The 95^{th} percentile results demonstrate that a 95^{th} percentile weather sequence would result in dose risk that is approximately 74% more than the average, and cost risk that is about 120% above the average (more than double). In contrast, a 5^{th} percentile weather sequence would result in a dose risk that is 38% of the average, and cost risk that is about 28%

of the average (nearly 1/4th). These cases demonstrate the large variability in dose risk and cost risk associated with weather conditions for a given release, and that the average dose risk and cost risk results are above the median.

F.7.3.2 EVACUATION SENSITIVITIES

NEI 05-01 specifies that the evacuation speed used in the Level 3 analysis should be assessed via sensitivities. Three sensitivity cases are performed to assess both the evacuation speed and the delay time to beginning evacuation. The base case WinMACCS model assumes a delay time prior to evacuation movement (e.g., public prepares to evacuate) and evacuation speeds for the two evacuating cohorts as follows:

- Cohort 1: 57 minutes delay, speed of 4.0 m/s (based on 90% ETE times)
- Cohort 2: 105 minutes delay, speed of 2.4 m/s (based on 100% ETE times)

The delay time and speed values are based on data provided in the CPS ETE study (KLD 2014). While evacuation assumptions do impact the population dose risk results, they generally have little impact on the cost risk because WinMACCS calculated cost risks are driven by land contamination levels, which generally remain unaffected by evacuation assumptions and the number of people evacuating.

The evacuation delay sensitivity case evaluates the impact of an increased delay time before evacuation begins (i.e., vehicles begin moving in the 10-mile region). For this sensitivity, the base case delay times were arbitrarily increased (i.e., double for Cohort 1 to 114 minutes, and increased by 50% for Cohort 2 to 157.5 minutes). The increased delay time results in a slight increase in dose risk (~0.1%). An increase in dose risk is generally expected because more individuals would be expected be exposed to the release due to their later departure (i.e., they failed to outrun the plumes). The limited impact is attributed to the frequency release category distribution (e.g., BOC and H/E releases are not dominant contributors to dose risk).

The second evacuation sensitivity case assesses the impact of evacuation speed by arbitrarily reducing (i.e., halving) the evacuation speed for each cohort (i.e., from 4.0 m/s to 2.0 m/s for Cohort 1, and from 2.4 m/s to 1.2 m/s for Cohort 2). The slower evacuation speed increases the dose risk slightly (~0.2%). An increase in dose risk is generally expected because individuals will tend to be subject to the plumes for a longer time when traveling more slowly (e.g., stuck in traffic). Similar to the delay sensitivity, the limited impact is attributed to the frequency release category distribution (e.g., BOC and H/E releases are not dominant contributors to dose risk).

The third evacuation sensitivity case assesses the impact of arbitrarily increasing the evacuation speed by a factor of two for each cohort (i.e., from 4.0 m/s to 8.0 m/s for Cohort 1, and from 2.4 m/s to 4.8 m/s for Cohort 2). The faster evacuation speed slightly decreases the dose risk (~0.1%) given that the evacuating public will be exposed to the plumes for less time when traveling faster.

The evacuation sensitivity cases demonstrate small dependence on the evacuation delay and speed values used. The limited impact is attributed to the frequency release category distribution (e.g., BOC and H/E releases are not dominant contributors to dose risk).

F.7.3.3 RELEASE HEIGHT & HEAT SENSITIVITIES

Three sensitivity cases were conducted to assess the impacts of the modeling assumptions and inputs related to the height of the release and thermal energy of the plumes. The CPS base case assumes the release occurs at the mid-height of the Containment (29.1 m above grade) with plume thermal energy typically in the range of 1.0E+6 to 1.0E+7 watts. It is noted that the Intact containment releases assume zero heat energy.

A ground level release (0.0 m) case was performed and shows a slight increase in dose risk (~0.2%) and a small decrease cost risk of <2%. An increase in dose for a lower release height is generally expected since the plumes will be closer to the evacuating public. The ground level release also tends to result in less dispersion of the plumes geographically due to the proximity of the plume to the ground, thereby decreasing the amount of land being contaminated and people impacted thereby decreasing the costs. The small changes in dose are attributed to the small contributions of the BOC and H/E release categories.

A second release height case was performed assuming each plume releases from the top of the Containment (58.2 m) rather than at mid-height. This case demonstrates the opposite effect of the ground release case, with the dose risk decreasing slightly (~0.2%) and the cost risk increasing a small amount (<2%) given the plumes releasing higher (and further vertically) from the evacuating public.

The third release sensitivity assumed zero thermal energy in each plume (a bounding assumption for a severe accident). The results follow the trend of a ground level release as generally expected. The dose risk increased slightly (~0.3%) and the cost risk decreased a small amount (<2%). Without the buoyancy effect of the thermal energy, the plumes remain closer vertically to the evacuating public increasing the dose.

These height and heat release-related sensitivity cases demonstrate small dependence (<2%) on release height and plume energy.

F.7.3.4 DEPOSITION VELOCITY SENSITIVITY

One sensitivity case was conducted to evaluate the impact of the fission product particle size released into the environment as reflected in the dry deposition velocity parameter in the WinMACCS model. As noted previously, WinMACCS can support a distribution of particle size groups. The WinMACCS sample problem inputs used for the CPS analysis includes ten particle size groups with a different dry deposition velocity for each group. The MELCOR thermal hydraulic code used by the NRC and its contractors can calculate and output the particle size data for each MELCOR case. MAAP 4.0.5 used by CPS is not able to produce equivalent data. To evaluate potential impacts of dry deposition inputs, an alternate modeling approach of a single dry deposition value was employed. The SOARCA Peach Bottom study (NRC 2013b) noted that the dominant or average dry deposition value in SOARCA was approximately 0.3 cm/sec. This sensitivity study replaces the ten-particle size group approach with a single particle size group with a 0.3 cm/sec dry deposition velocity based on SOARCA. This modeling change resulted in an increase of approximately 7% in population dose risk and 16% in cost risk showing some impact on results associated dry deposition velocity modeling.

F.7.3.5 POPULATION SENSITIVITY

One population sensitivity was performed to assess the relationship between dose risk and cost risk and the population. The CPS base case is based on a projected population to year 2047 for growing counties, and generally 2030 for counties with projected population declines. This sensitivity case uniformly increases the population by 30%. The increased population results in population dose risk and cost risk increases of 25% and 23%, respectively. This significant dependence on population estimates is expected given that the population dose and offsite economic costs are primarily driven by the regional population.

F.7.3.6 RESETTLEMENT PLANNING SENSITIVITIES

The WinMACCS consequence modeling incorporates an “intermediate phase” which depicts the time period following the release and immediate evacuation actions (termed the “early phase”) and extends to the time when recovery efforts such as decontamination and resettlement of people are begun (termed the “long term phase”). The intermediate phase thus models the time period when decontamination and resettlement plans are being developed. WinMACCS allows the habitation of land during the intermediate phase unless projected dose criteria are exceeded, in which case individuals are relocated. WinMACCS allows an intermediate phase ranging from no intermediate phase to a maximum of one year. The intermediate phase sensitivities show significant impacts and are therefore discussed further:

- The no intermediate phase case (i.e., decontamination starts sooner case) was developed based on the NUREG-1150 (NRC 1990a), and SOARCA Peach Bottom (NRC 2013b) and Surry (NRC 2013c) modeling approach. The 43% reduction in cost risk in the sensitivity results, however, is judged too optimistic in that the land decontamination efforts are modeled as starting one week after the accident (i.e., directly after the early phase ends) such that a significant portion of population relocation costs are omitted. For instance, the costs associated with temporary housing of interdicted individuals while decontamination strategies are developed and decontamination teams are contracted are not accounted for without an intermediate phase. It is believed that the NUREG-1150 studies omitted the intermediate phase because the intermediate phase coding was not validated at that time (NRC 1998). SOARCA Peach Bottom and Surry may have omitted the intermediate phase since it did not focus on economic costs. A competing aspect of the results of this sensitivity case is that the population dose increases (approximately 13%) because people are allowed to re-occupy the decontaminated land sooner and marginal doses continue to accrue.
- The one year intermediate phase case (i.e., decontamination starts later case) was developed based on the maximum length of time allowed by WinMACCS for the intermediate phase and modeling in SOARCA Sequoyah (NRC 2019b). A long intermediate phase can be unrealistic in that re-occupation of contaminated land is not performed during this phase even if contamination levels decrease (by natural radioactive decay and weathering) to levels which would allow it (i.e., resettlement is evaluated as part of the long-term phase, not the intermediate phase). Additionally, some decontamination strategies are straightforward and can begin relatively quickly (e.g., farmland decontamination dose reduction via soil inversion to bring clean soil to the surface and move contaminated topsoil below the surface). Therefore, population relocation costs may be overestimated using a long (i.e., one year) intermediate phase. An intermediate phase of one year shows a 40% increase in cost risk compared with the base case selection of 6 months. The population dose decreased by approximately 11% with a longer intermediate phase due to later resettlement on decontaminated land.

The six month intermediate phase (base case) is judged to be a best estimate approach in that it provides a reasonable time for both decontamination efforts and resettlement to begin. The sensitivity cases demonstrate that this six month modeling approach provides mid-range results of the modeling choices available and therefore is used as the base case.

F.7.3.7 DECONTAMINATION COST AND TIME SENSITIVITY

One sensitivity case was conducted examining the impact of assuming higher decontamination costs and longer time, based on the proceedings for the Indian Point license renewal. For Indian Point, the NRC requested sensitivity analysis of two specific MACCS inputs for decontamination of non-farmland. Specifically, for large releases (i.e., release categories with Cs-137 release greater than 10^{15} Bq), the time required to complete decontamination to a factor of 15 (variable TIMDEC) was increased to the code's maximum allowed value of one year. Also, the cost associated with this decontamination level (variable CDNFRM) was increased to the code's maximum allowed value of $100,000. Subsequently, the NRC began to ask for this sensitivity case from other licensees applying for license renewal (e.g., Seabrook (NRC 2016b)). This sensitivity case was therefore performed for CPS. The values of TIMDEC and CDNFRM were increased from 120 days and $28,823, respectively, to the maximum allowed code values of one year and $100,000, respectively, for the decontamination factor of 15. For conservatism this was done for all release categories, not just those exceeding a Cs-137 release of 10^{15} Bq. The sensitivity results show that the cost risk increases 18% by increasing these variables to the maximum allowed values. The change in dose risk was negligible (~0.1%).

F.7.3.8 RATE OF RETURN SENSITIVITIES

NEI 05-01 specifies that the real discount rate assumed in the SAMA evaluation should be 7% as the base case with an evaluation of 3% as a sensitivity case. The discount rate can be understood as the expected rate of return from an investment. One of the economic cost components included in the WinMACCS calculated cost result is the financial loss associated with property and associated improvements (e.g., buildings) not achieving their expected annual rate of return during interdiction periods. A piece of land that is interdicted (i.e., not occupied) for a period of years will not achieve the historical rate of return or the rate of return achieved by other non-impacted properties during the interdiction period. This lack of expected return is an economic loss for the owner/society. The CPS base case assumes a 7% expected rate of return, consistent with the NEI 05-01. Two discount rate sensitivity cases were performed to assess the impact of different values.

The first sensitivity case assumes a lower (i.e., 3%) expected rate of return consistent with that specified by NEI 05-01. This lower rate of return shows a decrease in the expected cost risk of approximately 10% and an increased dose risk of less than 1%. The decrease in cost risk associated with the lower rate of return is expected since there is a lower expectation associated with the land's return on investment. The dose risk change is due to the cost-benefit analysis performed by WinMACCS to determine the optimal strategy for remediation (e.g., decontamination vs condemnation).

The second sensitivity case assumes a higher (i.e., 12%) expected rate of return, the value used in NUREG-1150 (NRC 1990a) and SOARCA (NRC 2014). This results in an increased cost risk of approximately 11% and a decreased dose risk of less than 1%. This increase in cost risk associated with the higher rate of return is expected since there is a higher expectation associated with the land's return on investment. The dose risk change is due to the cost-benefit analysis performed by WinMACCS to determine the optimal strategy for remediation (e.g., decontamination vs condemnation.)

F.7.3.9 INGESTION DOSE SENSITIVITY

As discussed previously, ingestion dose has traditionally been modeled and included in the Level 3 consequence analyses for SAMA although NEI 05-01 is silent in this regard. The NUREG-1150 studies (NRC 1990a) included ingestion dose. The more recent NRC SOARCA studies (NRC 2013b, NRC 2013c, NRC 2019b) however chose not to include ingestion dose on the basis that food is plentiful in the U.S. and the general public would choose not to consume food produced on or water sourced from contaminated land. If the dose risk associated with ingestion of food and water from decontaminated land was omitted, the dose risk would decrease approximately 16%.

F.7.3.10 IMPACT ON SAMA ANALYSIS

Several different Level 3 input parameters and modeling assumptions are examined as part of the CPS WinMACCS sensitivity analysis. The primary reason for performing these sensitivity runs is to identify any reasonable changes that could be made to the Level 3 input parameters that would impact the conclusions of the SAMA analysis. While the table in Section F.7.3 summarizes the changes to the dose-risk and OECR estimates for each sensitivity case, it is prudent to consider if any of these changes would result in the retention of the SAMAs that were screened out using the baseline results.

Of all the WinMACCS sensitivity cases, the largest dose-risk increase is associated with the 95th percentile weather which increases by 74%, a factor of approximately 1.75. Similarly, the largest OECR increase is also associated with the 95th percentile weather which increases by approximately 120%, a factor of approximately 2.20. While these changes are not insignificant, they are bounded by the 95th percentile CDF PRA results sensitivity in Section F.7.2, which increases the averted cost-risk values for the SAMAs by a factor of approximately 2.45. Therefore, the 95th percentile CDF PRA results sensitivity case is considered to bound Level 3 95th percentile weather variability case and no SAMAs would be retained based on this sensitivity that were not already identified in Section F.7.2.

F.7.4 IMPACT OF REFINING THE FIRE MODELING FOR A SEVERE OIL FIRE IN THE TURBINE BUILDING (%F_T-1H_1TO02S_O_W)

Fire scenario "%F_T-1H_1TO02S_O_W" represents a conservative oil fire at the seal oil unit in the Turbine Building that fails all equipment and cables within the Turbine Building fire zone. In the current model, the scenario has a Fussell-Vesely value of 7.6E-2 for core damage and 1.4E-01 for the Medium-Early/Medium-Late release category group. While reviewing the scenario to identify potential SAMAs, it was determined that there are conservativisms in the modeling which, if refined, would reduce the importance of this scenario to a degree that the residual risk would be low enough to fall below the SAMA identification threshold for CPS. In order to support the conclusion that SAMAs are not required to address this fire scenario, a sensitivity case was developed to reflect plant risk after implementation of the modeling refinements.

<u>Assumptions:</u>

There are no specific assumptions related to the refinement of this fire scenario. See subsequent section for description of model changes.

<u>PRA Model Changes to Model SAMA:</u>

This fire scenario currently models a full room burnout that fails all targets within the fire zone, which is very conservative given the size and arrangement of the ignition source within the fire zone. To model a more realistic fire scenario, the scenario was modified to only include those targets within the immediate vicinity of the ignition source (i.e., within 30 feet of the ignition source).

Additionally, the basic event mapping for the RAT and ERAT relay interlock dependencies were modified to no longer fail the transformers themselves, but rather the supporting component (e.g., RAT relay interlock fails load circuit breaker instead of the transformer). The original mapping to the transformers was conservative and the detailed interlock mapping removes this source of conservatism.

Model Change(s):

The following changes were made to the fault tree:

- Under gates AGATE75 & AGATE04HPCS, replaced 1APCBAP221A1-K-- with gate CB221A1-FTC, which models ERAT relay interlock dependencies (basic event F-286-BE-1ET4).
- Under gate AGATE77, replaced 1APCBAP221B1-K-- with gate CB221B1-FTC, which models ERAT relay interlock dependencies (basic event F-286-BE-1ET4).
- Under gates AGATE79 & AGATE04HPCS, replaced 1APCBAP221C1-K-- with gate CB221C1-FTC, which models ERAT relay interlock dependencies (basic event F-286-BE-1ET4).
- Under gates AGATE71 & AGATE71-F, replaced 1APCB-521A---K-- with gate FTC-1AP04E-521A, which models RAT A relay interlock dependencies (basic event F-86-RTA).
- Under gates AGATE73 & AGATE73-F, replaced 1APCB-521B---K-- with gate FTC-1AP05E-521B, which models RAT A relay interlock dependencies (basic event F-86-RTA).
- Under gate AGATE66, replaced 1APCBAP201A1-K-- with gate CB201A1-FTC, which models RAT B relay interlock dependencies (basic event F-286-B1-1RT4).
- Under gate AGATE69, replaced 1APCBAP201B1-K-- with gate CB201B1-FTC, which models RAT B relay interlock dependencies (basic event F-286-B1-1RT4).
- Under gates AGATE98B & AGATE98B-F, replaced 1APCBAP221A1-K-- with gate CB221A1-FTC, which models RAT B relay interlock dependencies (basic event F-286-B1-1RT4).
- Under gates AGATE85B & AGATE85B-F, replaced 1APCBAP221B1-K-- with gate CB221B1-FTC, which models RAT B relay interlock dependencies (basic event F-286-B1-1RT4).
- Under gates TGATE03, TGATE07A, TGATE07A-F, TGATE09A & TGATE09A-F, replaced 1APCW--4538--F-- with gate RT-4538, which models RAT C relay interlock dependencies (basic event F-86-RTC).

The following changes were made to the fire model (i.e., FRANX model):

- Revised fire impacts for the fire scenario based on 2022 refinements.
- Removed cables associated with component "RAT-MOD" (addressed by other circuit analysis packages).
- Changed basic event mapping for the following components:

- 286-BE_1ET4_A_UA is now mapped to basic event F-286-BE-1ET4 instead of 1APTR--ERAT--F--
- 86-RTA_586_A_UA is now mapped to basic event F-86-RTA instead of 1APTR--RATA--F--
- 286-1E_1RT4_A_UA is now mapped to basic event F-286-B1-1RT4 instead of 1APTR--RATB--F--
- 86-RTC_A_UA is now mapped to basic event F-86-RTC instead of 1APTR--RATC--F--

Results of Sensitivity Model:

The following table summarizes the changes to the internal events, Fire, and total CDFs:

	FPIE CDF	Fire CDF	CDF (Total)
Base Value	2.91E-06	7.76E-05	8.05E-05
SAMA Value	2.91E-06	6.41E-05	6.70E-05
Percent Reduction	0	17.4	16.8

A further breakdown of the frequencies results are provided in the table below according to release category:

Release Category	Fire Freq.Base	Fire Freq.Sens	Percent Reduction
ST1 - BOC	0.00E+00	0.00E+00	0
ST2 - H/E	9.00E-07	9.56E-07	-6.2 (increase)
ST3 - H/L	2.63E-05	3.80E-05	-44.6 (increase)
ST4 - M/E	1.91E-05	4.41E-06	76.9
ST5 - M/L	2.15E-05	1.24E-05	42.1
ST6 - L/E	2.64E-06	5.45E-06	-106.4 (increase)
ST7 - L/L	2.23E-06	2.21E-06	1.1
ST8 - LL/E	3.50E-07	6.28E-07	-79.4 (increase)
ST9 - LL/L	4.10E-06	4.11E-06	-0.3 (increase)
ST10 - INTACT	5.00E-07	4.75E-07	5.0
Total	7.71E-05	6.83E-05	11.5

The updated importance values for the refined scenarios are below:

Initiating Event/Scenario	Description	F-V (CDF)	F-V (HEHL)	F-V (MEML)
%F_T-1H_1TO02S_O_Y	Fire at Seal Oil Unit 1TO02S (Severe) - ZOI - Initiator	4.2E-02	1.5E-02	1.0E-04

As can be seen, after implementing the refinements to the subject fire scenario, the Fussell-Vesely importance of initiator is below the SAMA Fussell-Vesely review threshold of 5.0E-02, and no SAMAs are required to address these contributors.

F.8 CONCLUSIONS

Using a SAMA methodology consistent with NEI 05-01, SAMAs 2, 7, 10, 12, 13, 14, and 15 were found to be potentially cost-beneficial in the baseline analysis.

When the 95th percentile PRA results are considered, SAMAs 4, 5, and 20 are also potentially cost-beneficial.

None of the SAMAs identified as potentially cost-beneficial are aging related and implementation is not required as a commitment for license renewal; however, CEG will formally evaluate these SAMA candidates for potential implementation at the plant.

F.8.1 OPTIMAL SAMA SET

While many SAMAs are potentially cost-beneficial for CPS when considered independently, it should be noted that many SAMAs address similar areas of risk. Implementation of one SAMA may result in a change in the potential benefits of the remaining SAMAs, such that they are no longer cost-beneficial. Review of the potentially cost-beneficial SAMAs can help identify an "optimal" set of SAMAs for implementation; that is, a reduced set of SAMAs that will address the largest risk contributors for the site. For example, the reliable hard pipe containment vent (SAMA 4) would provide venting capability without any support systems and, if implemented, would preclude the need for the procedure update to use the FLEX generators to provide power to the existing containment vent valves in non-ELAP scenarios (SAMA 12). It is recognized that there are different combinations of SAMAs that could achieve similar results, but this is a demonstration of a potential approach to interpreting the results of the cost benefit analysis.

Generally, implementing one SAMA in a group of functionally similar SAMAs would render the remaining SAMAs in the group non-cost-beneficial. The following table categorizes the potentially cost-beneficial SAMAs from Section F.8 and discusses the implications of SAMA implementation.

Impact of SAMA Implementation by Functional Group

SAMA Functional Group	SAMA Title	Discussion
Containment Heat Removal	SAMA 4: Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	At CPS, the current containment venting process relies on equipment for which electrical and instrument air support is required, and the vent valves may not function in some of the severe accident conditions in which containment venting would be required. SAMA 4 would provide a means of venting without support systems; hence, SAMA 12 would not be required if SAMA 4 were implemented.
	SAMA 12: Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	
RPV Inventory Control	SAMA 7: Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	SAMA 7 is designed to allow continued use of those pumps that take suction from the suppression pool when containment conditions are adverse. SAMA 10 would provide a means of injecting when there is no AC power to the ECCS pumps and it does not rely on the suppression pool; therefore, implementation of SAMA 10 would likely reduce the benefit of SAMA 7 such that it would no longer be cost beneficial.
	SAMA 10: Install a Hard Piped Connection Between FPS and RHR	
Electrical	SAMA 2: Proceduralize DC Current Check for ELAP Load Shed Action	SAMA 2 is a low cost change to help mitigate SBO scenarios. SAMAs 5, 14, and 20 each address different causes of AC power failure; however, SAMA 20 would reduce the scenarios that would require SAMA 2, mitigate scenarios in which fires would damage cables related to offside power distribution that would require SAMA 14, and prevent the need for a means of rapidly aligning power from the switchyard to the plant emergency buses (SAMA 5). It would also reduce the frequency of scenarios in which containment heat removal and/or injection was lost, which could reduce the benefit of SAMAs 4 and 10 to the point where they may no longer be cost beneficial. SAMA 15 may also no longer be cost beneficial given that the frequency of loss of power to the igniters would be significantly reduced.
	SAMA 5: Install an Emergency Tie Line From the Switchyard to an Emergency Bus	
	SAMA 14: Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	
	SAMA 20: Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	

Impact of SAMA Implementation by Functional Group

SAMA Functional Group	SAMA Title	Discussion
Containment Integrity	SAMA 15: Install a Battery Backup to the Hydrogen Igniters	Implementation of SAMA 15 would reduce the benefit of SAMAs that improve AC power reliability; however, the change would likely not be enough to make other SAMAs not cost beneficial. Implementation of SAMAs that improve AC power availability, such as SAMA 20, would likely reduce the benefit of SAMA 15 to the point where it may no longer be cost beneficial.
HVAC	SAMA 13: Alternate ECCS Pump Room Cooling	This SAMA addresses HVAC equipment failures for the ECCS pumps, which are associated with both RPV makeup and containment heat removal. Other SAMAs may each address part of the risks that this SAMA addresses, but none would address all of the risk and this SAMA would likely remain cost beneficial.

While a large number of SAMAs can be considered potentially cost-beneficial for CPS when considered independently, there is a smaller subset of SAMAs that, if implemented, would render the remaining SAMAs “not cost-beneficial”. This subset consists of SAMAs 20 and 13.

F.9 TABLES

Table F.2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%CDF	CDF (/YR)	CCDP
%LOOP	Loss of Offsite Power	Loss of Offsite Power	2.87E-02	53.78%	1.79E-06	6.24E-05
%FLFPMMCR	Major FP Rupture Above MCR	Internal Flooding	6.51E-05	9.32%	3.10E-07	4.77E-03
%TT	Turbine Trip	Turbine Trip	6.58E-01	6.75%	2.25E-07	3.42E-07
%FLSXAMMCR	Major SX A Rupture Above MCR	Internal Flooding	2.96E-05	4.24%	1.41E-07	4.77E-03
%FLSXBMMCR	Major SX B Rupture Above MCR	Internal Flooding	2.96E-05	4.24%	1.41E-07	4.77E-03
%TAC12E	Loss of 480 V Bus 0AP12E	Loss of Support Systems	2.93E-03	2.23%	7.43E-08	2.53E-05
%TAC11E	Loss of 480 V Bus 0AP11E	Loss of Support Systems	2.93E-03	2.15%	7.16E-08	2.44E-05
%TF	Loss of Feedwater	Other Transients	6.96E-02	1.89%	6.28E-08	9.02E-07
%MS	Manual Shutdown	Other Transients	1.05E+00	1.78%	5.91E-08	5.63E-08
%TC	Loss of Condenser Vacuum	Other Transients	6.72E-02	1.77%	5.89E-08	8.77E-07
%FLWSMAB	Major Service Water Rupture in AB	Internal Flooding	1.67E-05	1.25%	4.15E-08	2.48E-03
%CCW	Loss of CCW	Loss of Support Systems	1.00E+00	1.22%	4.06E-08	4.06E-08
%RAT	Loss of RAT	Loss of Support Systems	1.35E-02	1.10%	3.66E-08	2.71E-06
%FLFPMAB	Major Fire Protection Water Rupture in AB	Internal Flooding	1.05E-03	0.96%	3.19E-08	3.04E-05
%BOC-MS	Main Steam Line BOC	LOCA	9.58E-08	0.89%	2.98E-08	3.11E-01
%S2-WA	Small LOCA (Below TAF)	LOCA	1.57E-04	0.62%	2.07E-08	1.32E-04
%TM	MSIV Closure	Other Transients	1.98E-02	0.50%	1.66E-08	8.39E-07
%FLSXBMCB3A	Major SX B Rupture in Fire Area CB-3a	Internal Flooding	9.24E-06	0.47%	1.58E-08	1.71E-03
%TIA	Loss of Instrument Air	Loss of Support Systems	7.14E-03	0.43%	1.42E-08	1.99E-06
%FLSXBNSXB	Nominal SX/WS Pipe Rupture in SX B Room	Internal Flooding	1.18E-04	0.43%	1.42E-08	1.20E-04
%TAC4E	Loss of 6.9 KV Bus 1AP04E	Loss of Support Systems	5.68E-03	0.38%	1.28E-08	2.25E-06
%TI	Inadvertent Open Relief Valve	Other Transients	1.08E-02	0.32%	1.05E-08	9.71E-07
%S2-ST	Small LOCA (Above TAF)	LOCA	2.30E-04	0.27%	9.02E-09	3.92E-05
%S1-ST	Medium LOCA above TAF (steam LOCA)	LOCA	4.88E-05	0.23%	7.49E-09	1.54E-04

Table F.2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%CDF	CDF (/YR)	CCDP
%TAC05E	Loss of 480 V Bus 0AP05E	Loss of Support Systems	2.93E-03	0.22%	7.29E-09	2.49E-06
%TAC5E	Loss of 6.9 KV Bus 1AP05E	Loss of Support Systems	5.68E-03	0.22%	7.16E-09	1.26E-06
%TBCCW	Loss of TBCCW	Loss of Support Systems	1.00E+00	0.21%	6.96E-09	6.96E-09
%TAC06E	Loss of 480 V Bus 0AP06E	Loss of Support Systems	2.93E-03	0.20%	6.73E-09	2.30E-06
%TAC6E	Loss of 4 KV Bus 1AP06E	Loss of Support Systems	3.41E-03	0.20%	6.53E-09	1.91E-06
%ISLOCA-SDC	ISLOCA - RHR SDC Suction	LOCA	5.85E-09	0.17%	5.56E-09	9.51E-01
%FLSXBMAB	Major Shutdown Service Water B Rupture in AB	Internal Flooding	5.41E-05	0.15%	5.06E-09	9.36E-05
%TDC1E	Loss of DC Bus 1E	Loss of Support Systems	9.92E-04	0.14%	4.50E-09	4.53E-06
%S1-WA	Medium LOCA below TAF (water LOCA)	LOCA	2.71E-05	0.12%	4.13E-09	1.52E-04
%FLSXBMSXB	Major SX/WS Pipe Rupture in SX B Room	Internal Flooding	1.83E-05	0.11%	3.66E-09	2.00E-04
%FLCWNM	Nominal or Major Circulating Water Rupture in Turbine Building or Screenhouse	Internal Flooding	2.54E-03	0.10%	3.20E-09	1.26E-06
%TDC1F	Loss of DC Bus 1F	Loss of Support Systems	9.92E-04	0.09%	3.00E-09	3.02E-06
%FLWSNMCBTBSH	Nominal or Major Service Water rupture In the Control, Turbine, or Screenhouse buildings	Internal Flooding	7.13E-04	0.08%	2.73E-09	3.83E-06
%FLSXBNCB3A	Nominal SX B Rupture in Fire Area CB-3a	Internal Flooding	5.50E-05	0.07%	2.40E-09	4.36E-05
%FLFPNCB3A	Nominal FP Rupture in Fire Area CB-3a	Internal Flooding	2.70E-05	0.07%	2.26E-09	8.39E-05
%S1-HP	Medium LOCA in HPCS Line	LOCA	3.08E-06	0.06%	2.10E-09	6.81E-04
%R	Excessive LOCA	LOCA	1.00E-08	0.06%	1.86E-09	1.86E-01
%FLWSMHPCS	Major Service Water Rupture in HPCS Room	Internal Flooding	7.80E-06	0.05%	1.80E-09	2.31E-04
%S1-LP	Medium LOCA in LPCI Line	LOCA	1.15E-05	0.05%	1.67E-09	1.45E-04
%FLSXAMAB	Major Shutdown Service Water A Rupture in AB	Internal Flooding	2.02E-05	0.05%	1.57E-09	7.75E-05
%A-ADS	Inadvertent ADS	LOCA	1.00E-05	0.04%	1.40E-09	1.40E-04

Table F.2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%CDF	CDF (/YR)	CCDP
%FLFWNMTB	Nominal or Major Feedwater Rupture in Turbine Building	Internal Flooding	1.39E-03	0.04%	1.17E-09	8.38E-07
%FLSXBNCB5A	Nominal SX B Rupture in Div 3 Switchgear room	Internal Flooding	5.28E-05	0.03%	1.03E-09	1.96E-05
%A-ST	Large LOCA above TAF (steam LOCA)	LOCA	6.79E-06	0.03%	9.32E-10	1.37E-04
%TAC8E	Loss of 4 KV Bus 1AP08E	Loss of Support Systems	3.41E-03	0.03%	8.66E-10	2.54E-07
%ISLOCA-LPB	ISLOCA - RHR LPCI Train B	LOCA	8.02E-10	0.02%	7.66E-10	9.55E-01
%ISLOCA-LPC	ISLOCA - RHR LPCI Train C	LOCA	8.02E-10	0.02%	7.66E-10	9.55E-01
%ISLOCA-SDCB	ISLOCA - RHR SDC Return Train B	LOCA	8.02E-10	0.02%	7.66E-10	9.55E-01
%S1-CS	Medium LOCA in LPCS Line	LOCA	4.50E-06	0.02%	6.33E-10	1.41E-04
%A-LP	Large LOCA in LPCI Line	LOCA	3.39E-06	0.01%	4.33E-10	1.28E-04
%FLSXANCB5A	Nominal SX A Rupture in Div 3 Switchgear room	Internal Flooding	1.76E-05	0.01%	3.66E-10	2.08E-05
%TRLA	Break in Medium Range RX Water Reference Leg A	Loss of Support Systems	2.33E-03	0.01%	3.33E-10	1.43E-07
%TRLB	Break in Medium Range RX water Reference Leg B	Loss of Support Systems	2.33E-03	0.01%	3.33E-10	1.43E-07
%TSW	Loss of Service Water	Loss of Support Systems	1.00E+00	0.01%	3.33E-10	3.33E-10
%FLSXANSXA	Nominal SX/WS Pipe Rupture in SX A Room	Internal Flooding	6.58E-06	0.01%	3.33E-10	5.06E-05
%ISLOCA-CS	ISLOCA - LPCS Injection	LOCA	8.02E-10	0.01%	2.33E-10	2.91E-01
%ISLOCA-LPA	ISLOCA - RHR LPCI Train A	LOCA	8.02E-10	0.01%	2.33E-10	2.91E-01
%ISLOCA-SDCA	ISLOCA - RHR SDC Return Train A	LOCA	8.02E-10	0.01%	2.33E-10	2.91E-01
%A-HP	Large LOCA in HPCS Line	LOCA	8.71E-07	0.01%	2.00E-10	2.29E-04
%BOC-RW	Reactor Water Cleanup (RWCU) Suction BOC	LOCA	5.78E-10	0.01%	1.67E-10	2.88E-01
%BOC-RC	RCIC Line BOC	LOCA	5.78E-10	0.01%	1.67E-10	2.88E-01
%A-WA	Large LOCA below TAF (water LOCA)	LOCA	1.34E-06	0.01%	1.67E-10	1.24E-04

Table F.2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%CDF	CDF (/YR)	CCDP
%FLWSNHPCS	Nominal Service Water Rupture in HPCS Room	Internal Flooding	1.38E-05	0.01%	1.67E-10	1.21E-05
%FLSXCNSXC	Nominal SX/WS Pipe Rupture in SX C Room	Internal Flooding	2.80E-05	0.00%	1.33E-10	4.76E-06
%A-CS	Large LOCA in LPCS Line	LOCA	8.71E-07	0.00%	9.99E-11	1.15E-04
%FLFPNCB4	Nominal FP Rupture in Fire Area CB-4	Internal Flooding	2.49E-04	0.00%	9.99E-11	4.01E-07
%FLFWNMTUN	Nominal or Major Feedwater failure in the Main Pipe Tunnel	Internal Flooding	4.60E-05	0.00%	9.99E-11	2.17E-06
%BOC-HP	HPCS BOC	LOCA	1.80E-10	0.00%	6.66E-11	3.70E-01
%FLSXBNCB4	Nominal SX B Rupture in Fire Area CB-4	Internal Flooding	2.20E-05	0.00%	6.66E-11	3.03E-06
%BOC-FW	Feedwater Line BOC	LOCA	8.25E-11	0.00%	3.33E-11	4.04E-01
%FLSXANCB4	Nominal SX A Rupture in Fire Area CB-4	Internal Flooding	1.32E-05	0.00%	3.33E-11	2.52E-06
%FLSXAMCB	Major SX A Rupture in Control Building	Internal Flooding	7.93E-05	0.00%	3.33E-11	4.20E-07
%FLSXBMCB	Major SX B Rupture in Control Building	Internal Flooding	6.67E-05	0.00%	3.33E-11	4.99E-07
%FLSXCNCB5A	Nominal SX C Rupture in Div 3 Switchgear room	Internal Flooding	5.28E-05	0.00%	3.33E-11	6.31E-07
%FLSXNHPCS	Nominal SX Rupture in HPCS Room	Internal Flooding	6.15E-05	0.00%	3.33E-11	5.41E-07
%FLWONM	Nominal or Major Chilled Water rupture	Internal Flooding	8.30E-05	0.00%	3.33E-11	4.01E-07
%FLCCNM	Nominal or Major Component Cooling rupture	Internal Flooding	3.91E-05	0.00%	3.33E-11	8.52E-07
%FLRHRASNMRHRA	Nominal or Major RHR A Suppression Pool Suction Pipe Rupture	Internal Flooding	9.89E-08	0.00%	3.33E-11	3.37E-04
%FLRHRBSNMRHRB	Nominal or Major RHR B Suppression Pool Suction Pipe Rupture	Internal Flooding	7.41E-08	0.00%	3.33E-11	4.49E-04
%FLSXAMSXA	Major SX/WS Pipe Rupture in SX A Room	Internal Flooding	9.89E-07	0.00%	3.33E-11	3.37E-05
%FLFPNCB2	Nominal FP Rupture in Fire Area CB-2	Internal Flooding	5.39E-05	0.00%	0.00E+00	0.00E+00
%ISLOCA-FW	ISLOCA - FW Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00
%ISLOCA-HP	ISLOCA - HPCS Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00

Table F.2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%CDF	CDF (/YR)	CCDP
%FLCCMAB	Major Component Cooling rupture in area above RHR B/C in Aux Building	Internal Flooding	2.65E-07	0.00%	0.00E+00	0.00E+00
%FLFPMCB	Major Fire Water Rupture in Control Building	Internal Flooding	1.08E-03	0.00%	0.00E+00	0.00E+00
%FLFPNCB	Nominal Fire Water Rupture in Control Building	Internal Flooding	3.15E-03	0.00%	0.00E+00	0.00E+00
%FLFPNCB5	Nominal FP Rupture in Div 3 Switchgear room	Internal Flooding	4.72E-05	0.00%	0.00E+00	0.00E+00
%FLHPCSSNMHPCS	Nominal or Major HPCS Suction Pipe Rupture	Internal Flooding	4.94E-08	0.00%	0.00E+00	0.00E+00
%FLLPSNMLPCS	Nominal or Major LPCS Suppression Pool Suction Pipe Rupture in LPCS Room	Internal Flooding	2.97E-07	0.00%	0.00E+00	0.00E+00
%FLRHRCSNMRHRC	Nominal or Major RHR C Suppression Pool Suction Pipe Rupture	Internal Flooding	1.24E-07	0.00%	0.00E+00	0.00E+00
%FLRISMHPCS	Major RCIC Suction Rupture in HPCS Room	Internal Flooding	9.03E-09	0.00%	0.00E+00	0.00E+00
%FLRISNHPCS	Nominal RCIC Suction Rupture in HPCS Room	Internal Flooding	4.04E-08	0.00%	0.00E+00	0.00E+00
%FLRISNMRCIC	Nominal or Major RCIC Suppression Pool Suction Pipe Rupture in RCIC Room	Internal Flooding	4.94E-08	0.00%	0.00E+00	0.00E+00
%FLSXANCB	Nominal SX A Rupture in Control Building	Internal Flooding	4.81E-04	0.00%	0.00E+00	0.00E+00
%FLSXBNCB	Nominal SX B Rupture in Control Building	Internal Flooding	4.02E-04	0.00%	0.00E+00	0.00E+00
%FLSXBNCB2	Nominal SX B Rupture in Fire Area CB-2	Internal Flooding	4.31E-05	0.00%	0.00E+00	0.00E+00
%FLSXMCDB	Major SX Pipe Rupture in Control/Diesel Area	Internal Flooding	2.17E-05	0.00%	0.00E+00	0.00E+00
%FLWONCB5	Nominal WO Rupture in Div 3 Switchgear room	Internal Flooding	8.03E-06	0.00%	0.00E+00	0.00E+00
%FLWSMFB	Major Service Water Rupture in the Fuel Building	Internal Flooding	5.66E-06	0.00%	0.00E+00	0.00E+00
		Total CDF (/yr)	**-**	**99.98%[1]**	**3.33E-06**	**-**

Note to Table F.2.3.1-1:

(1) Rounding error based on importances generated from CAFTA.

Table F.2.3.1-2
Clinton FPIE CDF Contribution by Accident Class

ACCIDENT CLASS	SUBCLASS	DESCRIPTION	CDF (/YR)	%CDF
Class I	IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	6.34E-07	19.05%
	IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	5.17E-07	15.52%
	IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	1.03E-06	30.95%
	IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	7.76E-09	0.23%
	ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	1.37E-07	4.11%
	IE	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high and DC power is unavailable. (Grouped with Class IA)	-	-
Class II	II	Accident sequences involving a loss of containment heat removal.	-	-
	IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	6.81E-07	20.46%
	IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	1.50E-09	0.05%
	IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	1.32E-08	0.40%
	IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	9.50E-08	2.85%
	IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-

Table F.2.3.1-2
Clinton FPIE CDF Contribution by Accident Class

ACCIDENT CLASS	SUBCLASS	DESCRIPTION	CDF (/YR)	%CDF
Class III	IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	9.66E-10	0.03%
	IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	2.33E-09	0.07%
	IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	1.27E-08	0.38%
	IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	4.46E-09	0.13%
Class IV	IV	Accident sequences involving failure of adequate shutdown reactivity.	1.53E-07	4.61%
	IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
	IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or Stuck Open Relief Valve (SORV)); core damage induced post containment failure.	-	-
	IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
	IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
Class V	V	Unisolated LOCA outside containment.	3.88E-08	1.17%
		Total CDF (/yr)	**3.33E-06**	**100.00%**

Table F.2.3.2-1
Summary of Clinton FPIE Level 2 Release Category Frequencies (1),(2)

CDF (/YR)	INTACT(5)	LL/E	LL/I	LL/L	L/E	L/I	L/L	M/E	M/I	M/L	H/E(4)	H/I	H/L	RE
6.34E-07	5.23E-07	1.80E-09	-	3.14E-08	2.52E-09	-	5.71E-08	3.36E-10	-	1.32E-10	4.25E-09	-	1.42E-08	1
5.17E-07	0.00E+00(3)	4.05E-10	-	-	4.05E-07	-	-	4.65E-08	-	-	7.06E-08	-	-	5
1.03E-06	3.08E-07	-	-	7.42E-09	-	-	2.34E-07	-	-	1.93E-08	-	-	4.62E-07	7
7.76E-09	7.76E-09	-	-	1.53E-12	0.00E+00	-	0.00E+00	-	-	-	0.00E+00	-	-	1
1.37E-07	1.02E-07	6.20E-10	-	1.12E-08	1.12E-09	-	1.56E-08	1.22E-09	-	1.43E-10	1.38E-09	-	3.33E-09	3
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6.81E-07	0.00E+00(3)	-	-	-	-	-	-	1.70E-08	-	4.39E-07	1.27E-08	-	2.61E-07	7
1.50E-09	2.89E-10	-	-	-	-	-	-	-	-	2.21E-11	4.63E-11	-	1.14E-09	1
1.32E-08	4.04E-09	-	-	-	-	-	-	7.77E-11	-	8.14E-09	3.47E-11	-	8.88E-10	9
9.50E-08	4.58E-09	-	-	-	-	-	-	3.47E-09	-	8.42E-08	1.04E-10	-	2.64E-09	9
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
9.65E-10	9.26E-10	-	-	1.73E-11	4.10E-12	-	-	-	-	1.65E-11	1.65E-12	-	0.00E+00	3
2.33E-09	1.41E-09	6.22E-13	-	7.48E-11	4.42E-10	-	1.57E-10	6.41E-11	-	-	1.36E-10	-	4.47E-11	9
1.27E-08	1.06E-08	5.01E-12	-	7.45E-10	1.72E-10	-	8.58E-10	1.55E-11	-	-	5.29E-11	-	1.79E-10	2
4.46E-09	0.00E+00(3)	-	-	-	-	-	-	-	-	-	4.47E-09	-	-	4
1.53E-07	0.00E+00(3)	-	-	-	-	-	-	1.26E-07	-	-	3.28E-08	-	-	1
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3.88E-08	0.00E+00	-	-	-	-	-	-	-	-	-	3.88E-08	-	-	3
3.33E-06	**9.61E-07**	**2.83E-09**	**0.00E+00**	**5.09E-08**	**4.10E-07**	**0.00E+00**	**3.08E-07**	**1.94E-07**	**0.00E+00**	**5.51E-07**	**1.65E-07**	**0.00E+00**	**7.46E-07**	**2**

Table F.2.3.2-1:

Level 2 end states (other than H/E, which is the basis for LERF) were calculated at a truncation limit of 5E-13/yr due to "lack of memory" issues at the base LERF truncation (5E-14/yr).

A dash ("-") indicates that the accident class does not contribute to the release category.

A value of zero (0) in the "Intact" column indicates that the difference between CDF and the total release for that accident class is negative (i.e., less than zero) due to the rounding errors generated at the higher truncation limit. The differences are considered minor and do not affect risk insights used in risk applications.

The high / early (H/E) release category represents the LERF results.

The "Intact" frequency is calculated as the difference between CDF and the total release frequency for the given accident class.

Table F.2.3.2-2
Clinton FPIE LERF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%LERF	LERF (/YR)	CLERP
%LOOP	Loss of Offsite Power	Loss of Offsite Power	2.87E-02	45.06%	7.45E-08	2.60E-06
%BOC-MS	Main Steam Line BOC	LOCA	9.58E-08	18.01%	2.98E-08	3.11E-01
%TT	Turbine Trip	Turbine Trip	6.58E-01	15.29%	2.53E-08	3.84E-08
%ISLOCA-SDC	ISLOCA - RHR SDC Suction	LOCA	5.85E-09	3.37%	5.57E-09	9.53E-01
%TC	Loss of Condenser Vacuum	Other Transients	6.72E-02	1.82%	3.00E-09	4.47E-08
%TF	Loss of Feedwater	Other Transients	6.96E-02	1.76%	2.90E-09	4.17E-08
%TAC11E	Loss of 480 V Bus 0AP11E	Loss of Support Systems	2.93E-03	1.15%	1.89E-09	6.46E-07
%S1-ST	Medium LOCA above TAF (steam LOCA)	LOCA	4.88E-05	0.94%	1.55E-09	3.18E-05
%FLFPMMCR	Major FP Rupture Above MCR	Internal Flooding	6.51E-05	0.93%	1.54E-09	2.36E-05
%MS	Manual Shutdown	Other Transients	1.05E+00	0.86%	1.42E-09	1.35E-09
%TAC12E	Loss of 480 V Bus 0AP12E	Loss of Support Systems	2.93E-03	0.66%	1.09E-09	3.73E-07
%CCW	Loss of CCW	Loss of Support Systems	1.00E+00	0.60%	9.87E-10	9.87E-10
%R	Excessive LOCA	LOCA	1.00E-08	0.59%	9.74E-10	9.74E-02
%RAT	Loss of RAT	Loss of Support Systems	1.35E-02	0.59%	9.69E-10	7.18E-08
%S1-WA	Medium LOCA below TAF (water LOCA)	LOCA	2.71E-05	0.52%	8.56E-10	3.16E-05
%TM	MSIV Closure	Other Transients	1.98E-02	0.51%	8.48E-10	4.28E-08
%ISLOCA-LPB	ISLOCA - RHR LPCI Train B	LOCA	8.02E-10	0.46%	7.64E-10	9.52E-01
%ISLOCA-LPC	ISLOCA - RHR LPCI Train C	LOCA	8.02E-10	0.46%	7.64E-10	9.52E-01
%ISLOCA-SDCB	ISLOCA - RHR SDC Return Train B	LOCA	8.02E-10	0.46%	7.64E-10	9.52E-01
%TI	Inadvertent Open Relief Valve	Other Transients	1.08E-02	0.44%	7.19E-10	6.66E-08
%FLSXAMMCR	Major SX A Rupture Above MCR	Internal Flooding	2.96E-05	0.42%	6.98E-10	2.36E-05
%FLSXBMMCR	Major SX B Rupture Above MCR	Internal Flooding	2.96E-05	0.42%	6.98E-10	2.36E-05
%TDC1E	Loss of DC Bus 1E	Loss of Support Systems	9.92E-04	0.27%	4.38E-10	4.42E-07
%TDC1F	Loss of DC Bus 1F	Loss of Support Systems	9.92E-04	0.26%	4.30E-10	4.33E-07
%S2-WA	Small LOCA (Below TAF)	LOCA	1.57E-04	0.25%	4.20E-10	2.67E-06
%FLSXBMCB3A	Major SX B Rupture in Fire Area CB-3a	Internal Flooding	9.24E-06	0.25%	4.12E-10	4.45E-05

Table F.2.3.2-2
Clinton FPIE LERF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%LERF	LERF (/YR)	CLERP
%S1-LP	Medium LOCA in LPCI Line	LOCA	1.15E-05	0.22%	3.59E-10	3.12E-05
%TIA	Loss of Instrument Air	Loss of Support Systems	7.14E-03	0.21%	3.44E-10	4.82E-08
%S2-ST	Small LOCA (Above TAF)	LOCA	2.30E-04	0.20%	3.36E-10	1.46E-06
%A-ADS	Inadvertent ADS	LOCA	1.00E-05	0.19%	3.11E-10	3.11E-05
%TAC05E	Loss of 480 V Bus 0AP05E	Loss of Support Systems	2.93E-03	0.16%	2.66E-10	9.08E-08
%ISLOCA-CS	ISLOCA - LPCS Injection	LOCA	8.02E-10	0.15%	2.50E-10	3.11E-01
%ISLOCA-LPA	ISLOCA - RHR LPCI Train A	LOCA	8.02E-10	0.15%	2.50E-10	3.11E-01
%ISLOCA-SDCA	ISLOCA - RHR SDC Return Train A	LOCA	8.02E-10	0.15%	2.50E-10	3.11E-01
%TAC06E	Loss of 480 V Bus 0AP06E	Loss of Support Systems	2.93E-03	0.15%	2.45E-10	8.35E-08
%FLFPMAB	Major Fire Protection Water Rupture in AB	Internal Flooding	1.05E-03	0.15%	2.40E-10	2.28E-07
%TAC4E	Loss of 6.9 KV Bus 1AP04E	Loss of Support Systems	5.68E-03	0.15%	2.40E-10	4.22E-08
%FLWSMAB	Major Service Water Rupture in AB	Internal Flooding	1.67E-05	0.13%	2.18E-10	1.31E-05
%TBCCW	Loss of TBCCW	Loss of Support Systems	1.00E+00	0.13%	2.18E-10	2.18E-10
%TAC5E	Loss of 6.9 KV Bus 1AP05E	Loss of Support Systems	5.68E-03	0.13%	2.17E-10	3.81E-08
%A-ST	Large LOCA above TAF (steam LOCA)	LOCA	6.79E-06	0.13%	2.12E-10	3.12E-05
%FLSXBNSXB	Nominal SX/WS Pipe Rupture in SX B Room	Internal Flooding	1.18E-04	0.11%	1.87E-10	1.58E-06
%BOC-RW	RWCU Suction BOC	LOCA	5.78E-10	0.11%	1.80E-10	3.12E-01
%BOC-RC	RCIC Line BOC	LOCA	5.78E-10	0.11%	1.80E-10	3.12E-01
%TAC6E	Loss of 4 KV Bus 1AP06E	Loss of Support Systems	3.41E-03	0.09%	1.55E-10	4.56E-08
%S1-CS	Medium LOCA in LPCS Line	LOCA	4.50E-06	0.08%	1.39E-10	3.09E-05
%S1-HP	Medium LOCA in HPCS Line	LOCA	3.08E-06	0.08%	1.31E-10	4.24E-05
%TAC8E	Loss of 4 KV Bus 1AP08E	Loss of Support Systems	3.41E-03	0.07%	1.11E-10	3.25E-08
%A-LP	Large LOCA in LPCI Line	LOCA	3.39E-06	0.06%	1.04E-10	3.07E-05
%FLCWNM	Nominal or Major Circulating Water Rupture in Turbine Building or Screenhouse	Internal Flooding	2.54E-03	0.06%	9.92E-11	3.90E-08
%FLSXBMAB	Major Shutdown Service Water B Rupture in AB	Internal Flooding	5.41E-05	0.06%	9.75E-11	1.80E-06

Table F.2.3.2-2
Clinton FPIE LERF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%LERF	LERF (/YR)	CLERP
%FLWSNMCBTBSH	Nominal or Major Service Water rupture In the Control, Turbine, or Screenhouse buildings	Internal Flooding	7.13E-04	0.04%	5.79E-11	8.11E-08
%FLFPNCB3A	Nominal FP Rupture in Fire Area CB-3a	Internal Flooding	2.70E-05	0.04%	5.79E-11	2.14E-06
%BOC-HP	HPCS BOC	LOCA	1.80E-10	0.03%	5.62E-11	3.12E-01
%FLSXBNCB3A	Nominal SX B Rupture in Fire Area CB-3a	Internal Flooding	5.50E-05	0.03%	5.29E-11	9.62E-07
%FLSXBMSXB	Major SX/WS Pipe Rupture in SX B Room	Internal Flooding	1.83E-05	0.03%	5.12E-11	2.80E-06
%FLSXBNCB5A	Nominal SX B Rupture in Div 3 Switchgear room	Internal Flooding	5.28E-05	0.03%	4.96E-11	9.39E-07
%FLFWNMTB	Nominal or Major Feedwater Rupture in Turbine Building	Internal Flooding	1.39E-03	0.03%	4.79E-11	3.45E-08
%TRLA	Break in Medium Range RX Water Reference Leg A	Loss of Support Systems	2.33E-03	0.03%	4.63E-11	1.99E-08
%TRLB	Break in Medium Range RX water Reference Leg B	Loss of Support Systems	2.33E-03	0.03%	4.63E-11	1.99E-08
%A-WA	Large LOCA below TAF (water LOCA)	LOCA	1.34E-06	0.03%	4.13E-11	3.08E-05
%A-HP	Large LOCA in HPCS Line	LOCA	8.71E-07	0.02%	3.31E-11	3.80E-05
%A-CS	Large LOCA in LPCS Line	LOCA	8.71E-07	0.02%	2.64E-11	3.04E-05
%BOC-FW	Feedwater Line BOC	LOCA	8.25E-11	0.02%	2.48E-11	3.01E-01
%FLSXANCB5A	Nominal SX A Rupture in Div 3 Switchgear room	Internal Flooding	1.76E-05	0.01%	1.65E-11	9.39E-07
%FLFPNCB4	Nominal FP Rupture in Fire Area CB-4	Internal Flooding	2.49E-04	0.01%	1.65E-11	6.64E-08
%FLSXAMAB	Major Shutdown Service Water A Rupture in AB	Internal Flooding	2.02E-05	0.01%	1.49E-11	7.36E-07
%FLSXBNCB4	Nominal SX B Rupture in Fire Area CB-4	Internal Flooding	2.20E-05	0.01%	9.92E-12	4.51E-07
%FLWSMHPCS	Major Service Water Rupture in HPCS Room	Internal Flooding	7.80E-06	0.01%	8.27E-12	1.06E-06
%TSW	Loss of Service Water	Loss of Support Systems	1.00E+00	0.01%	8.27E-12	8.27E-12
%FLSXCNSXC	Nominal SX/WS Pipe Rupture in SX C Room	Internal Flooding	2.80E-05	0.00%	6.61E-12	2.36E-07
%FLSXANCB4	Nominal SX A Rupture in Fire Area CB-4	Internal Flooding	1.32E-05	0.00%	4.96E-12	3.76E-07
%FLSXANSXA	Nominal SX/WS Pipe Rupture in SX A Room	Internal Flooding	6.58E-06	0.00%	3.31E-12	5.02E-07

Table F.2.3.2-2
Clinton FPIE LERF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%LERF	LERF (/YR)	CLERP
%FLFWNMTUN	Nominal or Major Feedwater failure in the Main Pipe Tunnel	Internal Flooding	4.60E-05	0.00%	3.31E-12	7.19E-08
%FLWSNHPCS	Nominal Service Water Rupture in HPCS Room	Internal Flooding	1.38E-05	0.00%	1.65E-12	1.20E-07
%FLSXAMCB	Major SX A Rupture in Control Building	Internal Flooding	7.93E-05	0.00%	1.65E-12	2.08E-08
%FLSXBMCB	Major SX B Rupture in Control Building	Internal Flooding	6.67E-05	0.00%	1.65E-12	2.48E-08
%FLSXCNCB5A	Nominal SX C Rupture in Div 3 Switchgear room	Internal Flooding	5.28E-05	0.00%	1.65E-12	3.13E-08
%FLSXNHPCS	Nominal SX Rupture in HPCS Room	Internal Flooding	6.15E-05	0.00%	1.65E-12	2.69E-08
%FLWONM	Nominal or Major Chilled Water rupture	Internal Flooding	8.30E-05	0.00%	1.65E-12	1.99E-08
%FLFPNCB2	Nominal FP Rupture in Fire Area CB-2	Internal Flooding	5.39E-05	0.00%	1.65E-12	3.07E-08
%FLCCNM	Nominal or Major Component Cooling rupture	Internal Flooding	3.91E-05	0.00%	0.00E+00	0.00E+00
%FLRHRASNMRHRA	Nominal or Major RHR A Suppression Pool Suction Pipe Rupture	Internal Flooding	9.89E-08	0.00%	0.00E+00	0.00E+00
%FLRHRBSNMRHRB	Nominal or Major RHR B Suppression Pool Suction Pipe Rupture	Internal Flooding	7.41E-08	0.00%	0.00E+00	0.00E+00
%FLSXAMSXA	Major SX/WS Pipe Rupture in SX A Room	Internal Flooding	9.89E-07	0.00%	0.00E+00	0.00E+00
%ISLOCA-FW	ISLOCA - FW Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00
%ISLOCA-HP	ISLOCA - HPCS Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00
%FLCCMAB	Major Component Cooling rupture in area above RHR B/C in Aux Building	Internal Flooding	2.65E-07	0.00%	0.00E+00	0.00E+00
%FLFPMCB	Major Fire Water Rupture in Control Building	Internal Flooding	1.08E-03	0.00%	0.00E+00	0.00E+00
%FLFPNCB	Nominal Fire Water Rupture in Control Building	Internal Flooding	3.15E-03	0.00%	0.00E+00	0.00E+00
%FLFPNCB5	Nominal FP Rupture in Div 3 Switchgear room	Internal Flooding	4.72E-05	0.00%	0.00E+00	0.00E+00
%FLHPCSSNMHPCS	Nominal or Major HPCS Suction Pipe Rupture	Internal Flooding	4.94E-08	0.00%	0.00E+00	0.00E+00
%FLLPSNMLPCS	Nominal or Major LPCS Suppression Pool Suction Pipe Rupture in LPCS Room	Internal Flooding	2.97E-07	0.00%	0.00E+00	0.00E+00
%FLRHRCSNMRHRC	Nominal or Major RHR C Suppression Pool Suction Pipe Rupture	Internal Flooding	1.24E-07	0.00%	0.00E+00	0.00E+00

Table F.2.3.2-2
Clinton FPIE LERF Contribution by Initiating Event

INITIATING EVENT	DESCRIPTION	IE CATEGORY	IE FREQUENCY (/CRIT YR)	%LERF	LERF (/YR)	CLERP
%FLRISMHPCS	Major RCIC Suction Rupture in HPCS Room	Internal Flooding	9.03E-09	0.00%	0.00E+00	0.00E+00
%FLRISNHPCS	Nominal RCIC Suction Rupture in HPCS Room	Internal Flooding	4.04E-08	0.00%	0.00E+00	0.00E+00
%FLRISNMRCIC	Nominal or Major RCIC Suppression Pool Suction Pipe Rupture in RCIC Room	Internal Flooding	4.94E-08	0.00%	0.00E+00	0.00E+00
%FLSXANCB	Nominal SX A Rupture in Control Building	Internal Flooding	4.81E-04	0.00%	0.00E+00	0.00E+00
%FLSXBNCB	Nominal SX B Rupture in Control Building	Internal Flooding	4.02E-04	0.00%	0.00E+00	0.00E+00
%FLSXBNCB2	Nominal SX B Rupture in Fire Area CB-2	Internal Flooding	4.31E-05	0.00%	0.00E+00	0.00E+00
%FLSXMCDB	Major SX Pipe Rupture in Control/Diesel Area	Internal Flooding	2.17E-05	0.00%	0.00E+00	0.00E+00
%FLWONCB5	Nominal WO Rupture in Div 3 Switchgear room	Internal Flooding	8.03E-06	0.00%	0.00E+00	0.00E+00
%FLWSMFB	Major Service Water Rupture in the Fuel Building	Internal Flooding	5.66E-06	0.00%	0.00E+00	0.00E+00
		Total LERF (/yr)	-	**99.98%[(1)]**	**1.65E-07**	-

Note to Table F.2.3.2-2:

(1) Rounding error based on importances generated from CAFTA.

TABLE F.2.3.2-3

CLINTON FPIE LERF CONTRIBUTION BY ACCIDENT CLASS

ACCIDENT CLASS	SUBCLASS	DESCRIPTION	LERF (/YR)	%LERF
Class I	IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	4.25E-09	2.57%
	IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	7.06E-08	42.68%
	IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	-	-
	IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	0.00E+00	0.00%
	ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	1.38E-09	0.83%
	IE	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high and DC power is unavailable. (Grouped with Class IA)	-	-
Class II	II	Accident sequences involving a loss of containment heat removal.	-	-
	IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	1.27E-08	7.65%
	IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	4.63E-11	0.03%
	IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	3.47E-11	0.02%
	IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	1.04E-10	0.06%
	IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-

TABLE F.2.3.2-3

CLINTON FPIE LERF CONTRIBUTION BY ACCIDENT CLASS

ACCIDENT CLASS	SUBCLASS	DESCRIPTION	LERF (/YR)	%LERF
Class III	IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	1.65E-12	0.00%
	IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	1.36E-10	0.08%
	IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	5.29E-11	0.03%
	IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	4.47E-09	2.70%
Class IV	IV	Accident sequences involving failure of adequate shutdown reactivity.	3.28E-08	19.84%
	IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
	IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-
	IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
	IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
Class V	V	Unisolated LOCA outside containment.	3.88E-08	23.49%
		Total LERF (/yr)	**1.65E-07**	**100.00%**

TABLE F.2.4.1-1
CLINTON FIRE CDF BY PAU

PAU	DESCRIPTION	CDF (/YR)	%CDF
CB-6a	Main Control Room Complex - elevation 800'-0"	1.73E-05	22.36%
A-2k	Nonsafety Switchgear Room (East) - elevation 762'-0"	1.07E-05	13.75%
T-1h	General Access and Equipment - elevation 762'-0", 785'-0"	9.12E-06	11.77%
A-2n	Division 1 Switchgear Room - elevation 781'-0"	8.98E-06	11.59%
CB-3a	Auxiliary Electric Equipment Room - elevation 781'-0"	5.60E-06	7.23%
A-1b	General Access Area (North) - elevation 737'-0"	2.61E-06	3.37%
A-3f	Division 2 Switchgear Room - elevation 781'-0"	2.42E-06	3.13%
A-3d	Nonsafety Switchgear Room (West) - elevation 762'-0"	2.17E-06	2.80%
M-2c	Screen House and Tunnel - elevations 657'-6", 678'-0", 699'-0"	1.67E-06	2.15%
R-1i	General Access Area and Shops - elevation 737'-0"	1.62E-06	2.09%
CB-6d	Corridor and Miscellaneous Rooms - elevation 800'-0"	1.30E-06	1.68%
CB-1f	General Access Area - elevation 762'-0"	1.25E-06	1.62%
T-1f	General Access Area - elevation 737'-0"	1.25E-06	1.61%
CB-5a	Division 3 Switchgear Room - elevation 781'-0"	1.03E-06	1.33%
A-2b	RHR A Equipment Room - elevations 707'-6", 712'-0", 737'-0", 762'-0", 786'-6"	1.03E-06	1.33%
A-2c	LPCS Pump Room - elevations 707'-6", 712'-0"	9.18E-07	1.19%
CB-1i.1	Air Handling Equipment Area (West) - elevation 825'-0"	7.81E-07	1.01%
Other	All other PAUs	7.74E-06	9.99%
	Total CDF (/yr)	**7.75E-05**	**100.00%**

TABLE F.2.4.1-2

CLINTON FIRE CDF BY FIRE SCENARIO

SCENARIO	DESCRIPTION	CDF (/YR)	%CDF
%F_T-1H_1TO02S_O_W	Fire at Seal Oil Unit 1TO02S (Severe) - Undeveloped	6.15E-06	7.93%
%F_A-2K_1AP06E_H_O	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	1.67E-06	2.16%
%F_CB-6A_1H13-P744_E_Y	Fire at EP 1H113-P744 - ZOI	1.47E-06	1.90%
%F_CB-3A_1DC17E_E_Y	Fire at MCC 1DC17E - ZOI	1.36E-06	1.75%
%F_A-2K_1AP04E_H_O	Fire at 6.9kV MVSG 1AP04E (HEAF) - Beyond ZOI	1.35E-06	1.74%
%F_A-2K_1AP06E_H_Y2	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 2	1.31E-06	1.69%
%F_A-3D_1AP08E_H_Y	Fire at 4.16kV MVSG 1AP08E (HEAF) - ZOI	1.19E-06	1.54%
%F_R-1I_UNK-AHU_E_W	Fire at Unknown AHUs - Undeveloped	1.16E-06	1.50%
%F_CB-6A_1H13-P743_E_Y	Fire at EP 1H13-P743 - ZOI	1.14E-06	1.47%
%F_A-2K_1AP06E_H_Y1	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 1	1.11E-06	1.43%
%F_CB-3A_1PA06J_E_Y	Fire at EP 1PA06J - ZOI	1.07E-06	1.38%
%F_A-2N_1DC13E_E_Y	Fire at MCC 1DC13E - ZOI	1.07E-06	1.38%
%F_CB-6A_1H13-P704_E_Y	Fire at EP 1H13-P704 - ZOI	1.06E-06	1.37%
%F_A-2K_1AP04E_H_Y	Fire at 6.9kV MVSG 1AP04E (HEAF) - ZOI	1.03E-06	1.32%
%F_CB-5A/CB-5C_1E22S004_H_M	Fire at 4.16kV MVSG 1E22-S004 (HEAF) - MCA	9.43E-07	1.22%
%F_A-2N_1AP07E_H_O	Fire at 4.16kV MVSG 1AP07E (HEAF) - Beyond ZOI	8.64E-07	1.12%
%F_A-2N_1AP72E_E_Y	Fire at MCC 1AP72E - ZOI	8.49E-07	1.10%
Other	All other fire scenarios	5.27E-05	68.01%
	Total CDF (/yr)	**7.75E-05**	**100.00%**

TABLE F.2.4.1-3
CLINTON FIRE CDF BY ACCIDENT CLASS

SUBCLASS	DESCRIPTION	CDF (/YR)	%CDF
IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	1.18E-05	15.19%
IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	1.85E-05	23.82%
IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	1.24E-05	15.96%
IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	5.42E-09	0.01%
ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	2.81E-06	3.63%
II	Accident sequences involving a loss of containment heat removal.	-	-
IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	2.47E-05	31.89%
IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	1.65E-06	2.13%
IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	4.41E-06	5.69%
IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	1.11E-06	1.43%
IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-
IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	-	-
IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	5.29E-07	0.68%
IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	4.57E-07	0.59%
IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	1.78E-08	0.02%
IV	Accident sequences involving failure of adequate shutdown reactivity.	9.14E-08	0.12%
IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-

TABLE F.2.4.1-3
CLINTON FIRE CDF BY ACCIDENT CLASS

SUBCLASS	DESCRIPTION	CDF (/YR)	%CDF
IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
V	Unisolated LOCA outside containment.	-	-
	Total CDF (/yr)(1)	**7.84E-05(1)**	**101.16%(1)**

Note to Table F.2.4.1-3:

(1) The total %CDF contribution for all accident class basic events (RCVCL-*) is greater than 100% due to overlap in cutsets from the MCUB summation quantification process. The purpose of this table is to show the relative importance of the different accident classes, rather than to express the numerical importance of the different classes. This approach will be refined in a future update.

TABLE F.2.4.2-1

CLINTON FIRE LERF BY PAU

PAU	DESCRIPTION	LERF (/YR)	%LERF
T-1h	General Access and Equipment - elevation 762'-0", 785’-0”	6.27E-07	11.83%
A-2k	Nonsafety Switchgear Room (East) - elevation 762'-0"	6.12E-07	11.55%
CB-6a	Main Control Room Complex - elevation 800'-0"	5.78E-07	10.91%
A-2n	Division 1 Switchgear Room - elevation 781'-0"	5.55E-07	10.48%
CB-6d	Corridor and Miscellaneous Rooms - elevation 800'-0"	4.92E-07	9.29%
CB-3a	Auxiliary Electric Equipment Room - elevation 781'-0"	4.12E-07	7.78%
C-2	Containment - elevations 712’-0”, 737’-0”, 755’-0”, 778’-0”, 789’-1”, 803’-3”, 816’-7”, 828’-3”	2.73E-07	5.15%
A-3f	Division 2 Switchgear Room - elevation 781'-0"	2.02E-07	3.82%
A-1b	General Access Area (North) - elevation 737'-0"	1.99E-07	3.75%
CB-1f	General Access Area - elevation 762'-0"	1.58E-07	2.99%
CB-2	Division 2 Cable Spreading room - elevation 781'-0"	1.36E-07	2.56%
A-3d	Nonsafety Switchgear Room (West) - elevation 762'-0"	1.33E-07	2.50%
R-1i	General Access Area and Shops - elevation 737'-0"	1.01E-07	1.91%
CB-4	Division 1 Cable Spreading Room - elevation 781'-0"	6.82E-08	1.29%
M-2c	Screen House and Tunnel - elevations 657'-6", 678'-0", 699'-0"	6.70E-08	1.26%
CB-3e	Division 2 NSPS Inverter Room - elevation 781'-0"	6.54E-08	1.23%
T-1f	General Access Area - elevation 737'-0"	6.16E-08	1.16%
Other	All other PAUs	5.58E-07	10.53%
	Total LERF (/yr)	**5.30E-06**	**100.00%**

TABLE F.2.4.2-2

CLINTON FIRE LERF BY FIRE SCENARIO

SCENARIO	DESCRIPTION	LERF (/YR)	%LERF
%F_T-1H_1TO02S_O_W	Fire at Seal Oil Unit 1TO02S (Severe) - Undeveloped	4.30E-07	8.11%
%F_C-2_1G36-P002_E_O	Fire at CP 1G36-P002 - Beyond ZOI	2.37E-07	4.47%
%F_CB-6A_1H13-P744_E_Y	Fire at EP 1H113-P744 - ZOI	1.50E-07	2.83%
%F_CB-3A_1DC17E_E_Y	Fire at MCC 1DC17E - ZOI	1.16E-07	2.18%
%F_A-2K_1AP06E_H_O	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	1.02E-07	1.92%
%F_CB-6D_T01_T_O	Transient fire at Risers 10R88 & 10R106-10R108 - Beyond ZOI	9.85E-08	1.86%
%F_CB-6D_T02_T_O	Transient fire at Risers 10R600 & 10R61-10R62 - Beyond ZOI	9.85E-08	1.86%
%F_CB-6D_T03_T_O	Transient fire at Risers 10R117-10R119 - Beyond ZOI	9.85E-08	1.86%
%F_CB-6D_T04_T_O	Transient fire at Risers 10R65 & 10R120-10R121 - Beyond ZOI	9.85E-08	1.86%
%F_CB-6D_T05_T_O	Transient fire at Risers 10R165-10R168 - Beyond ZOI	9.85E-08	1.86%
%F_A-2N_1AP07E_H_O	Fire at 4.16kV MVSG 1AP07E (HEAF) - Beyond ZOI	9.81E-08	1.85%
%F_CB-6A_1H13-P704_E_Y	Fire at EP 1H13-P704 - ZOI	8.59E-08	1.62%
%F_A-2N_1C61-P001_E_O	Fire at RSP 1C61-P001 - Beyond ZOI	8.51E-08	1.61%
%F_A-2K_1AP04E_H_O	Fire at 6.9kV MVSG 1AP04E (HEAF) - Beyond ZOI	8.16E-08	1.54%
%F_A-2K_1AP06E_H_Y2	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 2	7.84E-08	1.48%
%F_CB-3A_1PA06J_E_Y	Fire at EP 1PA06J - ZOI	7.70E-08	1.45%
%F_A-3D_1AP08E_H_Y	Fire at 4.16kV MVSG 1AP08E (HEAF) - ZOI	7.57E-08	1.43%
%F_CB-1F_ERAT-BD_B09_O	Fire at Bus Duct 1ET4A1 (124-S) - Beyond ZOI	7.36E-08	1.39%
%F_R-1I_UNK-AHU_E_W	Fire at Unknown AHUs - Undeveloped	7.30E-08	1.38%
%F_CB-3E/CB-2_ALL_A_M	MCA Fire Scenario - CB-3e & CB-2 (PAU-level)	6.51E-08	1.23%
%F_A-2K_1AP06E_H_Y1	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 1	6.46E-08	1.22%
%F_A-2K_1AP04E_H_Y	Fire at 6.9kV MVSG 1AP04E (HEAF) - ZOI	5.99E-08	1.13%
%F_CB-6A_1H13-P743_E_Y	Fire at EP 1H13-P743 - ZOI	5.93E-08	1.12%
%F_A-2N_1AP73E_E_O	Fire at MCC 1AP73E - Beyond ZOI	5.47E-08	1.03%
%F_A-2N_1AP74E_E_O	Fire at MCC 1AP74E - Beyond ZOI	5.35E-08	1.01%
Other	All other fire scenarios	2.69E-06	50.72%
	Total LERF (/yr)	**5.30E-06**	**100.00%**

TABLE F.2.4.2-3
CLINTON FIRE LERF BY ACCIDENT CLASS

SUBCLASS	DESCRIPTION	LERF (/YR)	%LERF
IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	7.30E-07	13.77%
IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	2.82E-06	53.21%
IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	-	-
IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	-	-
ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	1.48E-08	0.28%
II	Accident sequences involving a loss of containment heat removal.	-	-
IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	1.01E-06	19.15%
IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	7.53E-08	1.42%
IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	6.71E-08	1.27%
IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	2.52E-08	0.48%
IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-
IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	-	-
IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	2.21E-07	4.17%
IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	3.23E-07	6.10%
IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	1.86E-08	0.35%
IV	Accident sequences involving failure of adequate shutdown reactivity.	5.17E-08	0.98%
IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-

TABLE F.2.4.2-3

CLINTON FIRE LERF BY ACCIDENT CLASS

SUBCLASS	DESCRIPTION	LERF (/YR)	%LERF
IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
V	Unisolated LOCA outside containment.	2.65E-10	0.01%
	Total LERF (/yr)[(1)]	**5.36E-06**[(1)]	**101.17%**[(1)]

Clinton FPIE / Internal Flooding PRA Peer Review Open Facts and Observations (Post F&O Closure)

Details	Basis for Significance	Possible Resolution	Status	Disposition from F&O Closure Review	Maintenance vs. Upgrade	Imp
A-004 Section 5.2 es the use of g values used for order to identify with dependent lowever, only twelve ver 100 basic events g post-initiator actions are listed in 2-1 as using g values to identify ency. Of these, six alue of 1.0E-02 and s a value of 1.0E-03. aining five use a 0.1. It appears that Hoes are quantified r nominal values. uch low probability s likely to result in ations of dependent eing omitted by on values. Use of a tly high value for required by SR QU- not using a tly high value would an inadequate nent of dependent .O originated from G7)	An inadequate process to identify combinations of operator actions can result in significantly underestimating CDF and LERF.	Solve with all post-initiator HEPs set to 1.0 and identify all combinations of operator action-related HEPs. Perform dependency analyses for all combinations.	Partially Resolved	<u>Clinton Assessment:</u> Section 5.3 and Appendix K of the Human Reliability Analysis Notebook (CL-PRA-004) (Reference 13) summarizes HRA Dependency Analysis methodology and results. For CDF and LERF, the FPIE model was quantified with all post-initiator HEPs set to 0.1 or higher at the truncation levels of 5E-9/yr (CDF) and 5E-10/yr (LERF). These truncation levels were selected because they capture all risk-significant post-initiator operator actions. Using the HRA Calculator Dependency Module, all dependent combinations were reviewed for proper dependency levels and order. Once reviewed, a floor value of 1E-06 or 5E-07 may be imposed on the dependent joint HEP depending on the timing of the operator actions. The final FPIE model quantification uses the 0.1 or higher seed values for all post-initiator HEPs and the adjusted dependent joint HEP is recovered using a post-processing recovery file. <u>Independent Review Team Assessment:</u> A check of the CAFTA RR Database indicates that the post-initiator HEPs were set to 0.1 (or greater) prior to dependency analysis. The value of 0.1 can be acceptable depending upon what truncation level is used for the dependency analysis and whether all multiple independent HFEs are recovered by combination HFEs and Joint HEPs. The resolution of this Finding is correlated to Finding 1-34.	<u>Clinton Assessment:</u> Maintenance: Methodology and tools consistent with previous PRA updates. <u>Independent Review Team Assessment:</u> Since no new methods were applied and existing methods were not applied in a different context, this constitutes model maintenance.	This analy depe curre A rev perfo comb depe depe unalt comb unan relat late) be as time- impa legiti ident incre grou overa Furth level is rec Ther docu
the PRA models he HEPs at nominal lt in cutsets with operator actions uncated out or with bined probability of ator actions much e 1E-6 or 5E-7 floor HRA notebook says The peer review antified the PRA ith post-initiator et to 0.1 and d a significant of cutsets containing ations of basic epresenting operator ilure. These ations were reviewed rge number of ations identified in ew were not in the CPS HRA ency evaluation. .O originated from G7)	The solution method used likely under predicts the risk values. This under prediction could be significant based on the total number of operator actions included in the CPS model.	Solve the PRA model with operator action failure probability values set to a high value.	Open	<u>Clinton Assessment:</u> See discussion for F&O 1-32. <u>Independent Review Team Assessment:</u> The CL-PRA-004 Rev. 6 document was reviewed. The final model cutsets were re-imported into the existing HRA DAF files (for FPIE CDF only), using a copy of the HRAC database with all 1.0 HEPs removed and the inhibit ADS also removed per the analyst notes for that HFE. This process was used to determine if there are combinations of HFEs occurring in the final results with all HEPs set to nominal values and no combination event applied. 318 new combinations were identified (in addition to the 216 that were originally identified and implemented), several of which had FV values above 5E-03 as calculated by the HRAC (which is not a true risk metric but a good approximation). For example, 1FWOPFLWCTRL-H-- and 1FWOPMANINIT-H-- appear as a combination together and have a dependency level of HD, confirmed in the HRA Calculator via override notes, however when this pair of HFEs appears together it is not recovered with a combination event. This combination has a an FV value of 2.9E-01 as calculated by the HRAC (again, not a true risk metric but a good approximation). This suggests it is likely risk significant when dependencies are accounted for, and additional unanalyzed combinations may also be present when dependencies are accounted for. The review teams concern is that potentially risk significant combinations of HFEs are not captured through the current approach, due to the chosen truncation level for the dependency identification (5E-9 / 5E-10 for CDF/LERF) in conjunction with the elevated HEP level chosen (0.1). This could under predict risk results as stated in the original F&O, and is supported by the observations noted above. It is noted that the example combination above did appear in the 1E-9 / 5E-11 identification cutsets that were included in the dependency files, but not used.	<u>Clinton Assessment</u>: Maintenance: Methodology and tools consistent with previous PRA updates. <u>Independent Review Team Assessment:</u> Maintenance - modeling error, approach will not change.	See

Clinton FPIE / Internal Flooding PRA Peer Review Open Facts and Observations (Post F&O Closure)

Details	Basis for Significance	Possible Resolution	Status	Disposition from F&O Closure Review	Maintenance vs. Upgrade	Imp
				Recommendations Show that risk significant combinations of HFEs appearing in the final results are all captured in the dependency analysis. Some suggestions on how to accomplish this are provided below. 1) Include more cutsets in the dependency identification process when imported into the HRAC. The total number of cutsets generated for the dependency analysis was low (5596 / 1014) which is likely the leading cause of this issue. The final model maintained the elevated HEP values for all HFEs, suggesting model quantification time is not an issue preventing the generation of additional cutsets through lowering of the identification truncation or increasing the HEP values above 0.1. This can be accomplished by either lowering the identification truncation levels, increasing the elevated HEP values, or both. The balance between these driving factors is model specific and may require some iteration. If this approach is chosen all identified combinations can be implemented if the model allows it, however a more refined approach can be accomplished by using risk metric cutoffs to select which combinations to implement, the use of optimized seed values, or both. 2) Show that the current set of combinations captures all risk significant combinations of HFEs when dependencies are accounted for through a sensitivity study on the final results. Using the final cutsets identify the unanalyzed combinations, and create additional recovery rules for them, using the conservative dependency levels automatically generated by the HRAC or refining as necessary. **Suggestion** For fire this issue may also exist, as the same identification truncation levels were used, and only 21237 / 11552 cutsets were generated. After re importing the final result cutsets for Fire CDF (using an HRAC file with the 1.0s removed), 78 additional combinations were identified, of which several had FV values above 5E-03 as calculated by the HRAC. Therefore, it is suggested that the Fire dependency analysis should be revisited in a similar manner.		

Table F.3-1
Residential Population Projection By County

County	2010 Census(1)	2020 IL Projections(1)	2030 IL Projections(1)	2020 Census(2)	2030 SAMA Projections(3)	2047 SAMA Projections(3)
Champaign	201,081	207,577	213,700	205,865	N/A	222,694
Christian	34,800	33,065	31,488	34,032	32,409	N/A
Coles	53,873	52,391	51,060	46,863	45,672	N/A
De Witt	16,561	15,643	14,808	15,516	14,688	N/A
Douglas	19,980	19,277	18,642	19,740	19,090	N/A
Ford	14,081	13,291	12,572	13,534	12,802	N/A
Iroquois	29,718	27,455	25,390	27,077	25,040	N/A
Livingston	38,950	36,792	34,829	35,815	33,904	N/A
Logan	30,305	28,534	26,921	27,987	26,405	N/A
Macon	110,768	101,707	93,429	103,998	95,534	N/A
Mason	14,666	12,851	11,188	13,086	11,393	N/A
McLean	169,572	180,504	190,696	170,954	N/A	198,346
Menard	12,705	12,603	12,518	12,297	12,214	N/A
Moultrie	14,846	14,589	14,363	14,526	14,301	N/A
Piatt	16,729	16,358	16,028	16,673	16,337	N/A
Sangamon	197,465	197,349	197,375	196,343	N/A(4)	196,413
Shelby	22,363	21,119	19,988	20,990	19,866	N/A
Tazewell	135,394	134,228	133,245	131,343	130,381	N/A
Vermilion	81,625	75,010	68,967	74,188	68,211	N/A
Woodford	38,664	39,617	40,521	38,467	N/A	40,885

Table F.3-1 Notes:

1. This data is from the Illinois Department of Public Health (IDPH 2021).
2. This data is from the U.S. Census Bureau (CB 2020).
3. The SAMA projections are calculated as discussed in the text. In general, declining counties are projected to year 2030 and growing counties are projected to year 2047 using the IDPH growth rates (IDPH 2021) from 2020 to 2030 but based on the 2020 census data (CB 2020).
4. Sangamon County was included with the growing counties based on its positive 2020-2030 projected growth (IDPH 2021) and projected to 2047. Had it been projected to 2030 instead based on its overall decline from 2010 the projected population for 2030 using the 2020 census data would be 196,369 persons, a negligible difference of 44 persons compared to the 2047 projection.

Table F.3-2
County Population Growth Rates 2010–2030/2047

County	2010 Census Population(1)	Projection End Year	2030/47 Projected Population(1)	Growth Rate 2010-2030/47 Percentage
Champaign	201,081	2047	222,694	10.7%
Christian	34,800	2030	32,409	-6.9%
Coles	53,873	2030	45,672	-15.2%
De Witt	16,561	2030	14,688	-11.3%
Douglas	19,980	2030	19,090	-4.5%
Ford	14,081	2030	12,802	-9.1%
Iroquois	29,718	2030	25,040	-15.7%
Livingston	38,950	2030	33,904	-13.0%
Logan	30,305	2030	26,405	-12.9%
Macon	110,768	2030	95,534	-13.8%
Mason	14,666	2030	11,393	-22.3%
McLean	169,572	2047	198,346	17.0%
Menard	12,705	2030	12,214	-3.9%
Moultrie	14,846	2030	14,301	-3.7%
Piatt	16,729	2030	16,337	-2.3%
Sangamon	197,465	2047(2)	196,413	-0.5%
Shelby	22,363	2030	19,866	-11.2%
Tazewell	135,394	2030	130,381	-3.7%
Vermilion	81,625	2030	68,211	-16.4%
Woodford	38,664	2047	40,885	5.7%

Notes to Table F.3-2:

1. For some counties with declining population growth, the year 2030 population is used in lieu of year 2047 to calculate the growth rate, discussed previously in the report.
2. Sangamon County was included with the growing counties based on its positive 2020-2030 projected growth and projected to 2047. Had it been projected to 2030 instead based on its overall decline from 2010 the projected population for 2030 using the 2020 census data would be 196,369 persons, a negligible difference of 44 persons compared to the 2047 projection.

Table F.3-3
Included Transient[3] Population Within a 10-Mile Radius, Year 2010

Sector	0-0.5 mile	0.5-1 mile	1-2 miles	2-3 miles	3-4 miles	4-5 miles	5-7 miles	7-10 miles	0-10 miles Total
N	0	0	0	185	0	15	0	0	200
NNE	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	67	0	67
E	0	0	0	0	0	208	0	0	208
ESE	0	0	0	1597	0	0	0	88	1685
SE	0	0	0	0	0	0	0	0	0
SSE	0	0	1080	0	0	0	0	0	1080
S	0	0	0	0	16	0	0	0	16
SSW	0	0	0	49	213	0	0	0	262
SW	0	0	0	63	103	0	720	90	976
WSW	0	0	0	92	0	0	552	1952	2596
W	0	0	75	0	0	0	389	206	670
WNW	0	0	0	0	0	0	0	0	0
NW	0	150	0	0	0	0	16	420	586
NNW	0	0	87	0	0	0	0	0	87
Total	**0**	**150**	**1242**	**1986**	**332**	**223**	**1744**	**2756**	**8433**

[3] Transient population includes traditional transients (lodging, recreation areas), employees, schools/daycares, and medical facilities based on data in the CPS ETE (KLD 2014).

Table F.3-4
SecPop 50-Mile Residential[4] Population Distribution, Year 2010

Sector	0-10 miles	10-20 miles	20-30 miles	30-40 miles	40-50 miles	50-mile Total
N	141	3,858	10,084	6,933	3,642	24,658
NNE	196	4,258	2,299	1,038	13,800	21,591
NE	109	490	1,489	5,052	2,859	9,999
ENE	424	2,702	3,328	14,534	8,981	29,969
E	151	1,748	39,445	103,189	9,081	153,614
ESE	83	2,934	8,912	16,922	6,810	35,661
SE	508	5,759	2,397	8,277	6,201	23,142
SSE	123	1,414	2,290	6,299	8,587	18,713
S	100	4,126	22,665	2,884	2,564	32,339
SSW	224	10,026	66,035	5,684	15,816	97,785
SW	460	1,827	2,904	3,535	14,153	22,879
WSW	5,106	951	2,780	2,150	52,545	63,532
W	3,608	755	19,156	2,436	4,791	30,746
WNW	692	963	3,713	4,576	19,491	29,435
NW	213	3,378	1,817	10,185	56,045	71,638
NNW	81	3,735	124,001	6,508	13,045	147,370
Total	**12,219**	**48,924**	**313,315**	**200,202**	**238,411**	**813,071**

[4] SecPop (NRC 2019a) residential data is based on year 2010 census.

Table F.3-5
10-Mile Projected Population Distribution, Year 2030/47[5]

Sector	0-0.5 mile	0.5-1 mile	1-2 miles	2-3 miles	3-4 miles	4-5 miles	5-7 miles	7-10 miles	0-10 miles Total
N	0	0	21	184	0	35	31	40	311
NNE	0	0	0	5	27	30	34	102	198
NE	0	0	2	0	4	9	23	59	97
ENE	0	0	6	156	5	21	97	150	435
E	0	0	0	11	39	219	10	40	319
ESE	0	0	0	1,416	6	4	20	134	1,580
SE	0	0	0	17	10	9	397	20	453
SSE	0	0	958	23	2	7	22	55	1,067
S	0	0	0	4	20	14	17	53	108
SSW	0	0	0	43	319	21	10	37	430
SW	0	0	0	56	91	51	790	286	1,274
WSW	0	0	0	82	40	4	2,721	3,984	6,831
W	0	0	104	51	6	15	2,215	1,404	3,795
WNW	0	0	0	3	0	12	51	548	614
NW	0	133	11	0	18	4	22	521	709
NNW	0	2	77	0	1	3	12	71	166
Total	**0**	**135**	**1,179**	**2,051**	**588**	**458**	**6,472**	**7,504**	**18,387**

[5] Population projection for 0-10 miles includes permanent residents, traditional transients (e.g., lodging, recreational areas), employees, schools/daycares, and medical facilities. This population projection is based on year 2010 census data and is projected to either 2030 or 2047 based on county growth characteristics as discussed in the text.

Table F.3-6
50-Mile Projected Population Distribution, Year 2030/2047[6]

Sector	0-10 miles	10-20 miles	20-30 miles	30-40 miles	40-50 miles	50-mile Total
N	311	4,513	11,795	8,109	3,170	27,898
NNE	198	4,981	2,689	1,214	12,012	21,094
NE	97	573	1,742	4,593	2,599	9,604
ENE	435	2,639	3,686	16,096	9,946	32,802
E	319	1,707	43,685	114,280	10,057	170,048
ESE	1,580	2,865	9,870	18,741	7,542	40,598
SE	453	5,624	2,341	7,908	5,925	22,251
SSE	1,067	1,381	2,236	6,068	8,272	19,024
S	108	3,559	19,548	2,778	2,278	28,271
SSW	430	8,647	56,953	4,902	14,729	85,661
SW	1,274	1,576	2,505	3,516	14,078	22,949
WSW	6,831	843	2,422	1,873	52,265	64,234
W	3,795	670	16,691	2,123	4,606	27,885
WNW	614	854	3,235	4,407	18,769	27,879
NW	709	3,951	2,125	9,808	53,970	70,563
NNW	166	4,369	145,042	7,612	13,794	170,983
Total	**18,387**	**48,752**	**326,565**	**214,028**	**234,012**	**841,744**

6 Population projection for 0-10 miles includes permanent residents, traditional transients (e.g., lodging, recreational areas), employees, schools/daycares, and medical facilities. Population projection for 10-50 miles includes permanent residents only. This population projection is based on year 2010 census data and is projected to either 2030 or 2047 based on county growth characteristics as discussed in the text.

Table F.3-7
WinMACCS Economic Parameter Inputs[(1)]

Variable	Description	Base Case Value
DPRATE	Property depreciation rate (per yr)	0.20
DSRATE[(2)]	Investment rate of return (per yr)	0.07
EVACST[(3)]	Daily cost for a person who has been evacuated ($/person-day)	261
RELCST	Daily cost for a person who is relocated ($/person-day)	261
POPCST	Population relocation cost ($/person)	18,204
CDFRM	Cost of farm decontamination for two levels of decontamination ($/hectare)[(4)]	DRF3: 2,018 DRF15: 4,490
TIMDEC	Decontamination time for each level[(4)]	DRF3: 60 days DRF15: 120 days
CDNFRM	Cost of non-farm decontamination per resident person for two levels of decontamination ($/person) [(4)]	DRF3: 10,786 DRF15: 28,823
DLBCST	Average cost of decontamination labor ($/man-year)	127,428
TFWKF	Time workers spend in farm land contaminated areas[(4)]	DRF3: 0.10 DRF15: 0.33
TFWKNF	Time workers spend in non-farm land contaminated areas[(5)]	DRF3: 0.33 DRF15: 0.33
VALWF0[(5)]	Weighted average value of farm wealth ($/hectare)	26,076
VALWNF[(5)]	Weighted average value of non-farm wealth ($/person)	514,570

1 Unless stated otherwise, values are based on SOARCA (NRC 2014), with costs escalated using a CPI multiplier of 1.517 to July 2022.

2 DSRATE based on NEI 05-01 (NEI 2005) and NUREG/BR-0058 (NRC 2004a).

3 Many of the economic cost values are "per person." In consideration of their reasonableness, it is noted that the average household size for DeWitt County, Illinois is approximately 2.32 (CB 2021) As an example, for an average household, the evacuation related costs (variable EVACST for food, housing, transportation) equates to $606/day.

4 Two decontamination levels are modeled based on SOARCA (NRC 2014). DRF3 is a dose reduction (decontamination) factor of 3 (reduction to 33%). DRF15 is a dose reduction factor of 15 (reduction to 6.7%).

5 VALWF and VALWNF are regional values calculated as land-area weighted values of SecPop (NRC 2019a) generated values for each grid element.

Table F.3-8
COMIDA2 Related Input Parameter Values7

PARAMETER	PARAMETER DESCRIPTION	VALUE EFFECTIVE (Rem)	VALUE THRYOID (Rem)
DOSEMILK	Maximum allowable food ingestion dose from milk crops during the year of the accident	0.25	2.5
DOSEOTHER	Maximum allowable food ingestion dose from non-milk crops during the year of the accident	0.25	2.5
DOSELONG	Maximum allowable long term annual dose to an individual from ingestion of the combination of milk and non-milk crops.	0.50	5.0

[7] Values are based on SOARCA (NRC 2014).

Table F.3-9
CPS Core Inventory[8]

Nuclide	Activity (Bq)	Nuclide	Activity (Bq)
Kr-85	5.37E+16	Tc-99m	5.85E+18
Kr-85m	1.14E+18	Ce-141	6.11E+18
Kr-87	2.31E+18	Ce-143	5.92E+18
Kr-88	3.12E+18	Ce-144	4.92E+18
Xe-133	7.07E+18	Np-239	8.03E+19
Xe-135	2.87E+18	Pu-238	1.43E+16
Cs-134	8.10E+17	Pu-239	1.43E+15
Cs-136	2.25E+17	Pu-240	2.63E+15
Cs-137	5.55E+17	Pu-241	5.66E+17
Rb-86	8.03E+15	Zr-95	6.51E+18
Ba-139	6.66E+18	Zr-97	6.29E+18
Ba-140	6.48E+18	Am-241	7.03E+14
Sr-89	4.29E+18	Cm-242	2.33E+17
Sr-90	4.26E+17	Cm-244	2.18E+16
Sr-91	5.33E+18	La-140	6.77E+18
Sr-92	5.51E+18	La-141	6.07E+18
I-131	3.54E+18	La-142	5.96E+18
I-132	5.14E+18	Nd-147	2.38E+18
I-133	7.25E+18	Pr-143	5.74E+18
I-134	8.29E+18	Y-90	4.40E+17
I-135	6.85E+18	Y-91	5.44E+18
Te-127	3.50E+17	Y-92	5.59E+18
Te-127m	6.03E+16	Y-93	6.07E+18
Te-129	1.02E+18	Rb-88	3.15E+18
Te-129m	1.96E+17	Y-91m	3.08E+18
Te-131m	7.25E+17	Nb-97	6.33E+18
Te-132	5.00E+18	Nb-97m	5.96E+18
Rh-105	4.18E+18	Rh-103m	6.14E+18
Ru-103	6.14E+18	Rh-106	2.99E+18
Ru-105	4.63E+18	Te-131	2.97E+18

8 CPS core inventory represents bounding isotopic values for varied enrichment and burnups based on the CPS core inventory calculation (Exelon 2021).

Table F.3-9
CPS Core Inventory[8]

Nuclide	Activity (Bq)	Nuclide	Activity (Bq)
Ru-106	2.69E+18	Xe-135m	1.54E+18
Nb-95	6.48E+18	Ba-137m	5.29E+17
Co-58	1.96E+16	Pr-144	4.92E+18
Co-60	2.35E+16	Pr-144m	6.88E+16
Mo-99	6.62E+18	--	--

Table F.3-10
WinMACCS Radioisotope Groups vs. CPS Level 2 Radioisotope Groups

WinMACCS Radioisotope Groups	CPS Level 2 Radioisotope Groups[4]
Xe	Noble Gases
Cs	CsOH[1]
Ba	BaO (& SrO[2])
I	CsI[3]
Te	TeO_2 (& Sb[4] & Te_2[5])
Ru	MoO_2[6]
Mo[7]	MoO_2
Ce	CeO_2 (& UO_2 [8])
La	La_2O_3

1 CsOH has traditionally been used to represent Cs in MACCS2 analyses. SOARCA (NRC 2014) identifies that the majority of Cs may be transported in the form of Cs_2MoO_4 based upon a new fission product release model for high burnup fuel. However, Cs_2MoO_4 is not trackable in MAAP 4.0.5. Therefore, the traditional assignment of CsOH is used.

2 Including SrO with BaO is a change with the WinMACCS sample problem as compared to the MACCS2 sample problem. The CPS core mass of Ba is about 1.7x that of Sr and the release fraction of SrO is typically less than BaO. Use of the BaO is therefore judged conservative with respect to Sr.

3 CsI has traditionally been used to represent iodine in MACCS2 analysis. This was maintained in SOARCA (NRC 2014).

4 The mass of Sb in the core is less than 1% the mass of Te.

5 The release fraction of Te_2 is typically much less than that of Te.

6 MoO_2 has traditionally been used to represent Ru. SOARCA documents do not discuss this assignment.

7 The Mo group is new for WinMACCS (as compared to MACCS2). SOARCA (NRC 2014) applied portions of Cs_2MoO_4 to the Mo group. Since Cs_2MoO_4 is not trackable in MAAP 4.0.5, MoO_2 is used to represent Mo (as well as Ru).

8 The mass of uranium in the core is typically much more than Ce, but the Ce release fraction is typically much more than uranium. Additionally, SOARCA (NRC 2014) notes that Ce has the potential to contribute to early dose. Cerium is typically released sooner than uranium in the accident. Therefore, CeO_2 is used to represent the Ce group to better model the timing.

Table F.3-11
CPS Level 2 Source Term Category Summary

Release Category	Description
H/E	High/Early Release
H/L	High/Late Release
M/E	Moderate/Early Release
M/L	Moderate/Late Release
L/E	Low/Early Release
L/L	Low/Late Release
LL/E	Low-Low/Early Release
LL/L	Low-Low/Late Release
OK	Containment OK

Table F.3-12
Level 2 End State Bins: Radionuclide Release
Severity and Timing Classification Scheme (Severity, Timing)[1]

Radionuclide Release Severity		Radionuclide Release Timing	
Classification Category	**Cs Iodide % in Release**	**Classification Category**	**Time of Initial Release[2] Relative to Declaration of a General Emergency**
High (H)	Greater than 10%	Late (L)	Greater than 24 hours
Moderate (M)	1% to 10%	Early (E)	Less than 4 hours
Low (L)	0.1% to 1%		
Low-Low (LL)	Less than 0.1%		
No iodine (OK, Intact Containment)	negligible		

1 Ten (10) Level 2 End State Bins: H/E, H/L, M/E, M/L, L/E, L/L, LL/E, LL/L, OK, Break Outside Containment (BOC-not shown but is a subset of H/E),

2 The General Emergency declaration is accident sequence dependent and occurs when Emergency Action Levels (EALs) are exceeded.

Table F.3-13
CPS Release Category Bins

Release Category	Bin
Break Outside Containment (High Magnitude / Early Release from Accident Class V, Unisolated LOCA Outside Containment)	H/E
High Magnitude / Early Release (non-BOC release)	H/E
High Magnitude / Late Release	H/L
Moderate Magnitude / Early Release	M/E
Moderate Magnitude / Intermediate Release Moderate Magnitude / Late Release	M/L
Low Magnitude / Early Release	L/E
Low Magnitude / Late Release	L/L
Low-low Magnitude / Early Release	LL/E
Low-low Magnitude / Late Release	LL/L
Containment Intact	INTACT

Table F.3-14
Detailed Release Category Frequencies

Release Category	FPIE[9] Freq (/yr)	Fire Freq (/yr)	Total Freq (/yr)	Contribution
ST1 - BOC	3.88E-08	0.00E+00	3.88E-08	0.048%
ST2 - H/E	8.22E-08	9.00E-07	9.82E-07	1.2%
ST3 - H/L	5.37E-07	2.63E-05	2.68E-05	33%
ST4 - M/E	1.62E-07	1.91E-05	1.93E-05	24%
ST5 - M/L	3.71E-07	2.15E-05	2.19E-05	27%
ST6 - L/E	3.30E-07	2.64E-06	2.97E-06	3.7%
ST7 - L/L	2.29E-07	2.23E-06	2.46E-06	3.1%
ST8 - LL/E	2.20E-09	3.50E-07	3.52E-07	0.44%
ST9 - LL/L	4.37E-08	4.10E-06	4.14E-06	5.1%
ST10 - INTACT	1.11E-06	5.00E-07	1.61E-06	2.0%
Total	**2.91E-06**	**7.76E-05**	**8.05E-05**	**100.0%**

[9] Full power internal events (FPIE) frequency includes the contribution from internal flooding events.

Table F.3-15
Representative MAAP Case Selection

Release Category	L2 Dominant Sequences	MAAP Cases Considered	Case Comments	Conclusion
ST1-BOC	MSL BOC and other ISLOCA sequences from the FPIE model. Fire model has no sequences above truncation.	One BOC case is available. Case CL110522 models a HPCS line break (10"), no injection.	The CsI release is very high.	CL110522 is chosen.
ST2-H/E(1)	Fire sequences dominate over FPIE by an order of magnitude, with the majority being Class IIA sequences.	A number of H/E cases are available, but the majority are ATWS or LLOCA scenarios (not caused by fire). Two Class IIA cases are available. CL110510 does not credit the upper pool dump. CL110510A credits the upper pool dump.	The CsI and CsOH release fractions for CL110510 are a little higher than those of CL110510A, making CL110510 a slightly more conservative choice. For Class II, the CPS L2 models a late GE 5% of the time at 35.1 hrs based on RPV level (resulting in an early release), and an early GE 95% of the time at 24 hrs based on discretion (resulting in a late release).	CL110510 (Class II) is chosen based on its higher release fractions, with a late GE applied (resulting in an early release).
ST3-H/L	Fire sequences dominate FPIE by more than an order of magnitude, with the majority being Class IIA sequences.	Two high magnitude Class IIA cases are available. CL110510 does not credit the upper pool dump. CL110510A credits the upper pool dump.	The CsI and CsOH release fractions for CL110510 are a little higher than those of CL110510A, making CL110510 a slightly more conservative choice. For Class II, the CPS L2 models a late GE 5% of the time at 35.1 hrs based on RPV level (resulting in an early release), and an early GE 95% of the time at 24 hrs based on discretion (resulting in a late release).	CL110510 (Class II) is chosen based on its higher release fractions, with an early GE applied (resulting in a late release).
ST4- M/E	Fire sequences dominate over FPIE by over two orders of magnitude, primarily Class IBE with containment isolation failure.	A number of M/E cases are available, including three Class IAs. CL110500B includes hydrogen deflagration and upper containment failure.	CL110500B has a much lower CsI and CsOH release as compared to the other two cases. which have releases that are similar in magnitude.	Case CL110501A is chosen based on its release magnitude and dominant sequences.

Table F.3-15
Representative MAAP Case Selection

Release Category	L2 Dominant Sequences	MAAP Cases Considered	Case Comments	Conclusion
		CL110501A includes 12" containment isolation failure and two vacuum breaker lines fail open. CL110501AA includes Drywell (DW) and CIV 10" isolation failure and two vacuum breaker lines fail open.	CL110501A & 501AA have releases that are similar in magnitude and timing.	
ST5-M/L	Fire sequences dominate over FPIE by more than an order of magnitude, with a mix of Class IBL, Class II, Class IA. Class IIA dominates the FPIE sequences.	One medium magnitude Class IIA case is available. CL110511 models a LOOP with LPCS, but no SPC or sprays. Upper containment fails causing a loss of injection.	For Class II, the CPS L2 models a late GE at 35.1 hrs based on RPV level (resulting in an early release) 5% of the time, and an early GE at 24 hrs based on discretion (resulting in a late release) 95% of the time.	CL110511 is chosen based on being a Class II case with a medium release, with an early GE applied (resulting in a late release).
ST6-L/E	Fire sequences dominate over FPIE nearly an order of magnitude. Dominant sequences for Fire and FPIE are a mix of Class ID, IA, and IBE sequences, dominated by containment isolation failure.	A number of L/E cases are available, but many are at the low end of CsI release for a low magnitude release. CL110501 is a Class IA with failure to isolate containment. Its CsI release is greater than similar cases. CL110503 is a class IBE with normally open vent not isolated. CsI is slightly less than the 501 case. CL110507A is a Class 1D with suppression pool failure. CL110511A is a Class II with venting failed.	CL110501 CsI release is greater than similar Class IA cases 501B and 501C, Class IB case 503, and Class ID cases 506C & 507. CL0507A and CL0511A have higher CsI and CsOH releases than CL110501 but dominant sequences do not include suppression pool failure or Class II.	CL11501 is chosen as reflecting the dominant sequences and having higher CsI and CsOH releases than alternative cases.

Table F.3-15
Representative MAAP Case Selection

Release Category	L2 Dominant Sequences	MAAP Cases Considered	Case Comments	Conclusion
ST7-L/L	Fire sequences dominate over FPIE by an order of magnitude. Dominant sequences are a mix of Class IBL, IA, and ID.	A number of low magnitude cases are available, but many are at the low end of CsI release for a low magnitude release and many are in the early time frame. CL110501 is a Class IA with failure to isolate containment. Its CsI release is greater than similar cases. CL110503 is a Class IBE with normally open vent not isolated. CsI is slightly less than the 501 case. CL110507A is a Class 1D with suppression pool failure. CL110511A is a Class II with venting failed.	CL110501 was selected for L/E and is therefore not selected for L/L. CL110503 CsI release is greater than similar Class IA cases 501B and 501C, and Class ID cases 506C & 507. Its open vent results in an early release which is conservative for the L/L RC. CL0507A and CL0511A have higher CsI and CsOH releases than CL110503 but dominant sequences do not include suppression pool failure or Class II.	Case 11503 is chosen reflecting the dominant sequences and its CsI release fraction being higher than other options.
ST8-LL/E	Fire sequences dominate FPIE by two orders of magnitude. Dominant sequences are a mix of Class ID and IA sequences, with some Class IIIC.	Two LL magnitude cases are available that exhibit good release fraction plateaus at the end of the run. CL110508 is a Class ID with upper containment failure. Its CsI release is low in the band and has a late release timing rather than early. CL110515A is a Class IIIC LLOCA with no injection, containment isolation failure, and containment sprays operating. The CsI release is high in the band with an early release timing.	CL110515A is a better choice for LL/E than 508 based on release timing. (Class CL110508 is selected for RC LL/L.)	CL110515A is chosen based on release timing.

Table F.3-15
Representative MAAP Case Selection

Release Category	L2 Dominant Sequences	MAAP Cases Considered	Case Comments	Conclusion
ST9-LL/L	Fire sequences dominate over FPIE almost two orders of magnitude. Dominant sequences are Class IA, with some Class IBL.	Two LL magnitude cases are available that exhibit good release fraction plateaus at the end of the run. Neither are Class IA sequences. CL110508 is a Class ID with upper containment failure. Its CsI release is low in the band and has a late release timing. CL110515A is a Class IIIC LLOCA with no injection, containment isolation failure, and containment sprays operating. The CsI release is high in the band with an early release timing.	CL110508 is a better choice for LL/L than 515A based on release timing. (Class CL110515A is selected for RC LL/E.)	CL110508 is chosen based on release timing.
ST10-INTACT	FPIE sequences dominate over Fire by more than a factor of two, with a mix of sequence classes.	Only one Intact containment case with containment leakage is available. CL220506E is a Class ID, with LPCS operating at RPV breach and SPC success.	CL220506E includes technical specification containment leakage with intact containment.	CL220506E is chosen.

1. H/E - High Early source term is the same end state as Large Early (e.g., LERF). BOC sequences are addressed as a separate source term.

Table F.3-16

Source Term MAAP Case Descriptions and Key Event Timings

Source Term	Rel. Cat. / MAAP Case	Representative Case Description	CsI RF(1)	Tcd (Hrs)(2)	Tvf (Hrs)(3)	Tcf (Hrs)(4)	Tend (Hrs)(5)
ST1	BOC CL110522	10" break on HPCS line, no injection (Class V)	0.99	0.38	3.8	(bypass)	38
ST2	H/E(6) CL110510	LOOP, LPCS, no SPC or sprays, SP failure below water line (no scrubbing of release), CF causes loss of all injection, GE called late (Class II)	0.22	38.9	49.0	34.5	84
ST3	H/L(6) CL110510	LOOP, LPCS, no SPC or sprays, SP failure below water line (no scrubbing of release), CF causes loss of all injection, GE called early (Class II)	0.22	38.9	49.0	34.5	84
ST4	M/E CL110501A	MSIV closure, no injection, no SRVs, no SPC, containment isolation fails (12"), vacuum breaker line stuck open (Class IA)	0.066	0.78	2.9	0.0 (isol. fails)	38
ST5	M/L CL110511	LOOP, LPCS, no SPC or sprays, upper containment failure, CF causes loss of all injection, GE called early (Class II)	0.014	39.0	48.6	34.5	84
ST6	L/E CL110501	MSIV closure, no injection, no SRVs, no SPC, containment isolation fails (12") (Class IA)	2.2E-3	0.78	2.9	0.0 (isol. fails)	38

Table F.3-16

Source Term MAAP Case Descriptions and Key Event Timings

Source Term	Rel. Cat. / MAAP Case	Representative Case Description	CsI RF(1)	Tcd (Hrs)(2)	Tvf (Hrs)(3)	Tcf (Hrs)(4)	Tend (Hrs)(5)
ST7	L/L CL110503	SBO, MSIV closure, 7 SRVs at TAF, no injection, no SPC, normally open vent isolation fails (10") (Class IBE/ID)	2.1E-3	0.53	3.8	0.0 (vent isol. fails)	40
ST8	LL/E CL110515A	LLOCA (20"), no injection, no SPC, containment isolation fails (12"), vacuum breaker line stuck open, containment sprays operate (Class III)	8.2E-4	0.13	2.9	0.0 (isol. fails)	38
ST9	LL/L CL110508	MSIV closure, 7 SRVs at TAF, no injection, no SPC, upper containment failure, (Class ID)	1.6E-4	0.53	3.8	38.3	72
ST10	INTACT CL220506E	MSIV closure, 7 SRVs at TAF, LPCS at RPV failure, SPC operates (Class ID)	2.7E-5	0.53	3.5	None (Tech Spec leakage only)	56

Notes to Table F.3-16:

1. CsI release fraction at the end of the MAAP calculation.
2. Tcd - Time of core damage (maximum core temperature >1800°F for more than 10 minutes)
3. Tvf - Time of vessel breach
4. Tcf – Time of containment failure or venting
5. Tend – Time at end of MAAP calculation
6. The High Early and High Late source terms are the same, with the difference being the time of GE. See Table F.3-17 for GE times for each release category.

Table F.3-17
Source Term Release Summary

	Release Category									
	ST 1 BOC	ST 2 H/E	ST 3 H/L	ST 4 M/E	ST 5 M/L	ST 6 L/E	ST-7 L/L	ST-8 LL/E	ST-9 LL/L	ST-10 INTACT
GE Time[1] (hr)	0.5	35.1	24.0	0.5	24.0	0.5	0.5	0.5	0.5	0.5
Plume 1 Start (hr)	0.33	38.7	38.7	0.75	38.8	0.75	0.50	0.17	38.3	0.50
Plume 1 Dur (hr)	1.00	1.6	1.6	2.25	4.7	3.25	3.5	2.0	4.7	10.0
Plume 1 Heat (w)	1.00E+07	1.00E+07	1.00E+07	1.00E+07	1.00E+07	1.00E+07	1.00E+07	1.00E+07	1.00E+07	0.00E+00
Plume 2 Start (hr)	1.33	40.3	40.3	3.0	43.5	4.0	4.0	2.2	43.0	10.5
Plume 2 Dur (hr)	1.00	9.0	9.0	3.0	1.0	3.0	2.0	4.0	10.0	10.0
Plume 2 Heat (w)	1.00E+07	5.00E+06	5.00E+06	5.00E+06	5.00E+06	5.00E+06	5.00E+06	5.00E+06	5.00E+06	0.00E+00
Plume 3 Start (hr)	2.34	49.3	49.3	6.0	44.5	7.0	6.0	6.2	53.0	20.5
Plume 3 Dur (hr)	10.0	4.0	4.0	3.0	10.0	10.0	4.0	10.0	10.0	10.0
Plume 3 Heat (w)	5.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	0.00E+00
Plume 4 Start (hr)	12.34	53.3	53.3	9.0	54.5	17.0	10.0	16.2	63.0	30.5
Plume 4 Dur (hr)	10.0	10.0	10.0	10.00	10.0	10.0	10.0	10.0	9.0	10.0
Plume 4 Heat (w)	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	0.00E+00
Fission Product Group:										
1) Noble Gases (Xe)										
Total Rel Fraction	1.00E+00	9.94E-01	9.94E-01	9.95E-01	1.00E+00	9.88E-01	9.99E-01	1.00E+00	1.00E+00	3.06E-02
Plume 1 Rel Fraction	9.85E-01	3.00E-01	3.00E-01	2.19E-01	6.28E-01	2.76E-01	1.51E-01	2.37E-01	1.00E+00	5.95E-03
Plume 2 Rel Fraction	1.35E-02	5.32E-01	5.32E-01	5.87E-01	3.44E-01	3.56E-01	3.97E-01	3.86E-01	0.00E+00	6.28E-03
Plume 3 Rel Fraction	1.27E-03	9.06E-02	9.06E-02	1.47E-01	2.73E-02	2.74E-01	2.66E-01	3.76E-01	0.00E+00	5.50E-03
Plume 4 Rel Fraction	0.00E+00	7.18E-02	7.18E-02	4.25E-02	7.17E-04	8.24E-02	1.86E-01	7.54E-04	0.00E+00	1.29E-02

Table F.3-17
Source Term Release Summary

	Release Category									
	ST 1 BOC	ST 2 H/E	ST 3 H/L	ST 4 M/E	ST 5 M/L	ST 6 L/E	ST-7 L/L	ST-8 LL/E	ST-9 LL/L	ST-10 INTACT
2) Cesium (Cs)										
Total Rel Fraction	9.89E-01	2.12E-01	2.12E-01	7.23E-02	5.58E-03	2.01E-03	6.58E-04	7.59E-04	5.65E-04	6.80E-06
Plume 1 Rel Fraction	8.90E-01	1.24E-01	1.24E-01	2.98E-05	1.20E-03	3.84E-05	1.40E-04	3.63E-04	1.20E-04	4.42E-06
Plume 2 Rel Fraction	2.55E-02	7.26E-02	7.26E-02	5.67E-02	1.88E-03	1.12E-03	3.40E-04	1.82E-04	5.75E-05	1.50E-06
Plume 3 Rel Fraction	6.46E-02	4.49E-03	4.49E-03	1.46E-02	4.89E-04	5.68E-04	1.44E-04	1.45E-04	3.62E-04	4.99E-07
Plume 4 Rel Fraction	8.92E-03	1.02E-02	1.02E-02	1.07E-03	2.01E-03	2.83E-04	3.42E-05	6.95E-05	2.58E-05	3.81E-07
3) Barium (Ba)										
Total Rel Fraction	1.01E-01	1.61E-02	1.61E-02	8.37E-06	4.42E-04	1.42E-04	9.50E-05	8.88E-05	3.92E-06	2.36E-07
Plume 1 Rel Fraction	7.42E-02	6.96E-03	6.96E-03	2.88E-07	9.52E-05	5.17E-07	5.61E-06	6.42E-05	1.65E-08	1.55E-07
Plume 2 Rel Fraction	1.15E-02	8.14E-03	8.14E-03	6.90E-06	8.93E-05	1.30E-04	7.01E-05	2.46E-05	5.15E-11	5.11E-08
Plume 3 Rel Fraction	1.52E-02	1.03E-03	1.03E-03	1.06E-06	2.50E-04	1.09E-05	1.61E-05	0.00E+00	1.09E-06	1.72E-08
Plume 4 Rel Fraction	1.00E-07	1.52E-05	1.52E-05	1.23E-07	7.97E-06	6.60E-07	3.20E-06	0.00E+00	2.81E-06	1.33E-08
4) Iodine (I)										
Total Rel Fraction	9.94E-01	2.17E-01	2.17E-01	6.61E-02	1.35E-02	2.19E-03	2.07E-03	8.20E-04	1.60E-04	2.74E-05
Plume 1 Rel Fraction	8.90E-01	1.24E-01	1.24E-01	1.33E-04	1.27E-03	1.04E-04	4.53E-04	4.52E-04	2.36E-05	1.79E-05
Plume 2 Rel Fraction	2.54E-02	8.88E-02	8.88E-02	6.34E-02	7.14E-03	5.43E-04	1.26E-03	3.68E-04	6.51E-06	6.34E-06
Plume 3 Rel Fraction	7.69E-02	4.18E-03	4.18E-03	2.44E-03	1.72E-03	6.75E-04	3.36E-04	5.38E-07	8.71E-05	2.12E-06
Plume 4 Rel Fraction	1.33E-03	0.00E+00	0.00E+00	8.49E-05	3.40E-03	8.66E-04	1.89E-05	0.00E+00	4.23E-05	1.09E-06

Table F.3-17
Source Term Release Summary

	Release Category									
	ST 1 BOC	ST 2 H/E	ST 3 H/L	ST 4 M/E	ST 5 M/L	ST 6 L/E	ST-7 L/L	ST-8 LL/E	ST-9 LL/L	ST-10 INTACT
5) Tellurium (Te)										
Total Rel Fraction	9.77E-01	2.27E-01	2.27E-01	6.99E-02	3.80E-03	7.96E-04	3.01E-04	4.23E-04	5.40E-04	3.13E-06
Plume 1 Rel Fraction	8.48E-01	1.33E-01	1.33E-01	3.38E-05	1.56E-03	4.00E-05	7.10E-05	3.04E-04	2.92E-07	2.09E-06
Plume 2 Rel Fraction	4.34E-02	9.17E-02	9.17E-02	6.63E-02	1.32E-03	6.09E-04	1.30E-04	9.84E-05	1.52E-08	6.71E-07
Plume 3 Rel Fraction	3.80E-02	2.21E-03	2.21E-03	3.38E-03	1.35E-04	8.50E-05	4.64E-05	2.10E-05	2.16E-04	2.26E-07
Plume 4 Rel Fraction	4.83E-02	1.60E-06	1.60E-06	1.98E-04	7.94E-04	6.16E-05	5.28E-05	4.23E-07	3.24E-04	1.47E-07
6) Ruthenium (Ru)(2)										
Total Rel Fraction	7.92E-02	1.17E-02	1.17E-02	2.32E-06	1.01E-04	3.42E-07	1.12E-05	6.51E-05	1.76E-08	1.67E-07
Plume 1 Rel Fraction	6.63E-02	4.55E-03	4.55E-03	1.70E-07	4.46E-05	1.49E-07	3.96E-06	6.51E-05	9.67E-09	1.10E-07
Plume 2 Rel Fraction	1.27E-02	6.99E-03	6.99E-03	2.13E-06	4.79E-05	1.54E-07	6.60E-06	5.86E-08	0.00E+00	3.64E-08
Plume 3 Rel Fraction	3.05E-04	2.01E-04	2.01E-04	2.67E-08	8.77E-06	1.22E-08	5.78E-07	0.00E+00	1.06E-09	1.21E-08
Plume 4 Rel Fraction	0.00E+00	0.00E+00	0.00E+00	1.21E-10	0.00E+00	2.72E-08	5.43E-08	0.00E+00	6.91E-09	9.22E-09
7) Molybdenum (Mo)(2)										
Total Rel Fraction	7.92E-02	1.17E-02	1.17E-02	2.32E-06	1.01E-04	3.42E-07	1.12E-05	6.51E-05	1.76E-08	1.67E-07
Plume 1 Rel Fraction	6.63E-02	4.55E-03	4.55E-03	1.70E-07	4.46E-05	1.49E-07	3.96E-06	6.51E-05	9.67E-09	1.10E-07
Plume 2 Rel Fraction	1.27E-02	6.99E-03	6.99E-03	2.13E-06	4.79E-05	1.54E-07	6.60E-06	5.86E-08	0.00E+00	3.64E-08
Plume 3 Rel Fraction	3.05E-04	2.01E-04	2.01E-04	2.67E-08	8.77E-06	1.22E-08	5.78E-07	0.00E+00	1.06E-09	1.21E-08
Plume 4 Rel Fraction	0.00E+00	0.00E+00	0.00E+00	1.21E-10	0.00E+00	2.72E-08	5.43E-08	0.00E+00	6.91E-09	9.22E-09
8) Cerium (Ce)										
Total Rel Fraction	5.01E-02	1.59E-03	1.59E-03	8.87E-06	6.79E-04	4.12E-04	2.23E-04	6.24E-05	2.25E-06	6.73E-09
Plume 1 Rel Fraction	9.80E-04	1.11E-04	1.11E-04	4.43E-08	1.82E-06	4.01E-07	5.90E-07	9.00E-07	1.12E-08	3.89E-09
Plume 2 Rel Fraction	2.79E-04	1.70E-04	1.70E-04	6.60E-06	2.27E-06	3.73E-04	1.54E-04	6.15E-05	0.00E+00	1.67E-09

Table F.3-17
Source Term Release Summary

	Release Category									
	ST 1 BOC	ST 2 H/E	ST 3 H/L	ST 4 M/E	ST 5 M/L	ST 6 L/E	ST-7 L/L	ST-8 LL/E	ST-9 LL/L	ST-10 INTACT
Plume 3 Rel Fraction	4.88E-02	1.27E-03	1.27E-03	2.12E-06	6.61E-04	3.84E-05	6.27E-05	0.00E+00	1.25E-06	6.80E-10
Plume 4 Rel Fraction	0.00E+00	3.98E-05	3.98E-05	9.36E-08	1.43E-05	8.97E-08	5.31E-06	0.00E+00	9.97E-07	4.95E-10
9) Lanthanum (La)										
Total Rel Fraction	5.32E-03	2.73E-04	2.73E-04	6.06E-07	5.07E-05	3.06E-05	2.34E-05	6.99E-06	9.99E-08	3.67E-09
Plume 1 Rel Fraction	7.63E-04	5.79E-05	5.79E-05	8.42E-09	8.93E-07	4.89E-08	1.56E-07	8.41E-07	1.14E-09	2.34E-09
Plume 2 Rel Fraction	2.48E-04	1.34E-04	1.34E-04	5.12E-07	1.67E-06	2.83E-05	1.83E-05	6.15E-06	0.00E+00	8.34E-10
Plume 3 Rel Fraction	4.31E-03	7.96E-05	7.96E-05	8.29E-08	4.74E-05	2.30E-06	4.62E-06	0.00E+00	5.42E-08	2.99E-10
Plume 4 Rel Fraction	0.00E+00	1.59E-06	1.59E-06	2.69E-09	7.01E-07	0.00E+00	3.49E-07	0.00E+00	4.45E-08	1.92E-10

Notes to Table F.3-17:

1. General Emergency (GE) times are based on CPS procedures as discussed in the Appendix G of the CPS Level 2 PRA analysis (Exelon 2020).
2. See the notes of Table F.3-10 for discussion of both the Ru and Mo release fractions being based on MAAP MoO_2 (and hence the same values).

Table F.3-18
Year 2020 Meteorological Data Void Filling

Data	Interpolation	Substitution
10m Wind Direction	3 hrs (<0.04%)	21 hrs (<0.3%)
10m Wind Speed	3 hrs (<0.04%)	21 hrs (<0.3%)
Delta Temperature (Stability)	3 hrs (<0.04%)	21 hrs (<0.3%)
Precipitation	0 hrs (0%)	17 hrs (<0.2%)

Table F.3-19
WinMACCS Base Case Mean Results

Release Category	Frequency (per yr)	Dose (p-rem)	Dose Risk (p-rem /yr)	Dose Risk Contrib. (%)	Offsite Economic Cost ($)	OECR ($/yr)	OECR Contrib. (%)
ST1 - BOC	3.88E-08	5.26E+06	2.04E-01	0.3%	4.68E+10	1.82E+03	0.2%
ST2 - H/E	9.82E-07	1.63E+06	1.60E+00	2.3%	2.59E+10	2.54E+04	2.6%
ST3 - H/L	2.68E-05	1.63E+06	4.37E+01	64.1%	2.59E+10	6.95E+05	72.2%
ST4 - M/E	1.93E-05	8.23E+05	1.59E+01	23.3%	1.04E+10	2.00E+05	20.8%
ST5 - M/L	2.19E-05	2.72E+05	5.95E+00	8.7%	1.71E+09	3.73E+04	3.9%
ST6 - L/E	2.97E-06	1.49E+05	4.41E-01	0.6%	6.84E+08	2.03E+03	0.2%
ST7 - L/L	2.46E-06	7.64E+04	1.88E-01	0.3%	2.92E+08	7.19E+02	0.1%
ST8 - LL/E	3.52E-07	7.56E+04	2.66E-02	0.04%	2.52E+08	8.87E+01	0.01%
ST9 - LL/L	4.14E-06	4.76E+04	1.97E-01	0.3%	1.45E+08	6.00E+02	0.06%
ST10 - INTACT	1.61E-06	1.73E+03	2.79E-03	0.004%	1.39E+07	2.24E+01	0.002%
Total	**8.05E-05**	**--**	**6.81E+01**	**100.0%**	**--**	**9.63E+05**	**100.0%**

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1--SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
%LOOP	2.87E-02	0.53776	LOSS OF OFFSITE POWER INITIATOR	There are a diverse set of contributors to Loss of Offsite Power scenarios for CPS. Top contributors include CCF of the EDG HVAC fans (17.2%), DC load shedding failure (16.1%), failure of RCIC after FLEX realignment (15.5%), and failure to recover DHR in the long term (13.8%). Potential plant enhancements to address these issues include: 1) providing portable DG room HVAC equipment and procedures (SAMA 1), 2) Include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2), 3) For the FPIE, protection of the RCIC storage tank and ensuring it has adequate volume for long term RCIC operation would provide an alternate means of maintaining core cooling when combined with containment venting (SAMA 3), and 4) enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).
1DGRXDGREC30MH--	1.00E+00	0.3108	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	The diesel recovery failure event is set to 1.0 (no credit taken for recovery of a failed diesel). No specific insights have been identified related to this event, though the same SAMAs that were identified for the %LOOP event would be applicable.

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-1BL	1.00E+00	0.30952	ACCIDENT CLASS IBL	This is a flag event that identifies the contributions from long term station blackout scenarios. A top contributor (27%) to this class is the failure of RCIC after realignment of the suction to the RHR system. Protecting the RCIC storage tank and ensuring it has adequate volume for long term RCIC operation would provide an alternate means of maintaining core cooling when combined with containment venting (SAMA 3), which would reduce the risk of these events. Of the remaining contributors, about 21% of the are related to DG room HVAC failures, which can be addressed by portable HVAC equipment (SAMA 1). Additional large contributors are EDG run failures and the failure to align power to the plant AC buses after offsite power recovery. Because common cause failure is a major contributor to EDG unavailability and because establishing a basis for excluding an additional EDG from the same common cause group is difficult, an additional EDG is not suggested as a SAMA to address this risk. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5). It is noted that RPV depressurization failure is include in LOOP-092; however, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long term scenarios.
RCVSEQ-LOOP-092	1.00E+00	0.28813	ACCIDENT SEQUENCE LOOP-092	This event is a sequence marker flag. Sequence LOOP-092 is a long term SBO (IBL) scenario and the contributors are already addressed by the RCVCL-1BL event on this list.

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CVPH-SMALLD-F--	1.00E+00	0.20732	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	This event identifies that the small diameter vent paths are not a viable venting mechanism and not credit is taken for use of those paths. It is combined with failures of the credited vent path, which is dominated by failure of the in-containment vent path AOV failing to open due to environmental stress. Providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of addressing this risk (SAMA 4).
RCVCL-2A	1.00E+00	0.20458	ACCIDENT CLASS IIA	This is the accident class IIA flag. There are a wide range of failures that contribute to this accident sequence, but the dominant contributor (99%) is the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which is addressed by SAMA 4. An additional large contributor is the failure to recover RHR given success of the "dump" of the upper pool to the main suppression pool (provides more time to reach PCPL). This is a data-based event and no specific insight has been identified related to RHR repair apart from that when RHR is not available, and alternate means of heat removal is required, which can also be accomplished with SAMA 4. An additional failure (22%) is related to the lack of power to a vent valve leading to the inability to operate the valve, and the assumption that it is initially in the correct "isolated" position. Again, SAMA 4 addresses this failure.
RCVCL-1A	1.00E+00	0.19052	ACCIDENT CLASS IA	This is the accident class IA flag. MCR flooding is the dominant contributor to class IA scenarios at CPS. Some screening level events, such as the HFE for manual shutdown of the plant at the remote shutdown panel (RSP), if refined, may reduce the importance of these scenarios. Assuming there are no means of reducing probabilities of failing to evacuate the MCR or of controlling the plant from the RSP, physical

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				modifications could be performed to protect the MCR from water ingress during flooding events (SAMA 6).
RCVSEQ-GTR-036	1.00E+00	0.18828	ACCIDENT SEQUENCE GTR-036	This is the accident sequence flag for GTR-036, which is a class IA sequence . The SAMAs identified for event RCVCL-1A are applicable.
1XXPH-FLRSPRQH--	1.00E-01	0.17789	FAILURE TO SHUTDOWN PLANT USING REMOTE SHUTDOWN PANEL	The event is related to MCR flooding and the subsequent need to evacuate and perform plant shutdown from the remote shutdown panel. These are predominantly the Class IA scenarios discussed above for flag event RCVCL-1A.
1MCR-ABANDON	5.00E-02	0.17789	FLOOD (MAJOR) IN CB-1I CAUSES ABANDONMENT IN MCR	The event is related to MCR flooding and the subsequent need to evacuate and perform plant shutdown from the remote shutdown panel. These are predominantly the Class IA scenarios discussed above for flag event RCVCL-1A.
1RHRX-REC-UPDH--	2.43E-01	0.16376	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	This event represents the failure to recover the RHR system for heat removal given that the upper pool inventory was successfully transferred to the lower pool (provides more time to reach adverse containment conditions). 84% are Class IIA scenarios, which are addressed by the SAMAs discussed for the RCVCL-2A event. An additional 11.5% are Class IIV scenarios, which include successful containment vent followed by injection failure. A dominant contributor to the Class IIV scenarios is the failure to control the containment vent process to maintain NPSH for the pumps taking suction from the suppression pool. Currently, the CPS procedures do not provide specific guidance for controlling venting to preserve injection pump operation and operator training does not extend to long term scenarios to provide detailed practice on this action. A potential enhancement would be to include guidance in the EOPs related to controlling vent pressure to maintain NPSH and to include this action in the training program (SAMA 7). In addition, the probability of failing

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				to properly align an adequate containment venting path is a significant contributor venting failure. Providing a pathway that is straightforward to use, is operable under adverse conditions without support systems, and having directions the clearly direct selection of the vent path would improve reliability (SAMA 4).
1SMSY-SUCC---F--	9.90E-01	0.16376	SUCCESS OF UPPER POOL DUMP	This event represents the successful transfer of the upper pool inventory to the lower pool (provides more time to reach adverse containment conditions). 84% are Class IIA scenarios, which are addressed by the SAMAs discussed for the RCVCL-2A event. An additional 11.5% are Class IIV scenarios, which include successful containment vent followed by injection failure. A dominant contributor to the Class IIV scenarios is the failure to control the containment vent process to maintain NPSH for the pumps taking suction from the suppression pool. Currently, the CPS procedures do not provide specific guidance for controlling venting to preserve injection pump operation and operator training does not extend to long term scenarios to provide detailed practice on this action. A potential enhancement would be to include guidance in the EOPs related to controlling vent pressure to maintain NPSH and to include this action in the training program (SAMA 7). In addition, the probability of failing to properly align an adequate containment venting path is a significant contributor venting failure. Providing a pathway that is straightforward to use, is operable under adverse conditions without support systems, and having directions the clearly direct selection of the vent path would improve reliability (SAMA 4).

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-1BE	1.00E+00	0.1552	ACCIDENT CLASS IBE	This is the accident class IBE flag. About 60% of the Class IBE contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). About 30% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar contributors for different time intervals. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).
RCVSEQ-LOOP-099	1.00E+00	0.152	ACCIDENT SEQUENCE LOOP-099	This is the accident sequence LOOP-099 flag. This is accident class IBE and the SAMAs discussed to address the risk from event RCVCL-1BE are applicable to this event.
1APSYLOOPIESWF--	2.40E-01	0.15019	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	This event is the fractional contribution of LOOP events that are weather related. The contributors include failure of RCIC after alignment of the suction to RHR in ELAP scenarios, failure of DC load shedding, failure of EDG Room HVAC fans, and the inability of the small containment vent paths to remove adequate heat from containment. These contributors are addressed by SAMAs 3, 2, 1, and 4, respectively. Additional contributors include common cause EDG failures. While providing an additional 4KV EDG is not likely to greatly mitigate these common cause failures, protecting the RCIC storage tank and providing long term makeup such that RPV injection does not rely on suppression pool cooling would reduce the risk of the scenarios that include EDG failures (SAMA 3).

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTSYLRGPCFLLR--	2.00E-01	0.13629	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability of a severe containment failure after overpressure in loss of containment heat removal scenarios. Over 98% include the event marking the inability of the smaller diameter vent paths being unable to adequately reduce containment pressure. Providing a full capacity containment vent path that is straightforward to use, can be operated without support systems, and is designed to work in adverse containment conditions would address these scenarios (SAMA 4). These scenarios include other events that lead to failure of the existing vent path, such as failing to operate the existing vent path (18%), failure of the inboard containment valve to operate due to environmental stress (69%), and failure of various components in the RHR system.
1CVPH-TEMPF--F--	1.00E-02	0.11946	IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1)	This event represents the probability that the inboard containment vent air operated valve fails to open when required for venting. SAMA 4 suggests the installation of a hardpipe vent that other BWRs have implemented as part of the FLEX designs. An alternative may be to replace the inboard containment vent valve with one that is qualified to operate in severe accident conditions (SAMA 8).
1APSYLOOPIESYF--	4.50E-01	0.10939	COND. PROBABILITY LOOP DUE TO SWYD EVENT	Similar to event 1APSYLOOPIESWF--, this is the fractional contribution of LOOP events that are related to events in the switchyard. The contributors include failure of RCIC after alignment of the suction to RHR in ELAP scenarios, failure of DC load shedding, and failure of EDG Room HVAC fans. These contributors are addressed by SAMAs 3, 2, and 1, respectively. Additional contributors include common cause EDG failures. While providing an additional 4KV EDG is not likely to greatly mitigate these common cause failures, protecting the RCIC storage tank and providing long

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				term makeup such that RPV injection does not rely on suppression pool cooling would reduce the risk of the scenarios that include EDG failures (SAMA 3).
1VDFNVD01CABCXCC	5.85E-05	0.10084	FANS VD01CA B AND C FAIL TO RUN - CC	This event represents the common cause failure fans that are part of the EDG room HVAC system. A potential plant enhancement to address this is to provide portable DG room HVAC equipment and to develop procedures that would direct their use in any scenarios in which other means of EDG room cooling have failed (SAMA 1).
1APRXOSP6HRSWH--	5.47E-01	0.09963	FAILURE TO RECOVER OSP WITHIN 6 HOURS (WEATHER RELATED LOOP EVENT)	This event represents the failure to recover offsite power within 6 hours given that it was caused by a weather event. These are longer term LOOP event for which RCIC initially runs. Almost 30% include failure of RCIC to run after alignment to the RHR Hx output as part of the FLEX strategy, which is addressed by providing a protected RCIC storage tank (SAMA 3). An additional 15% are related to common cause DG HVAC fan failures, which can be mitigated by the use of portable HVAC equipment (SAMA 1). An additional 13% of the contribution is related to the failure to align the FLEX pump to cool the RHR heat exchangers. This action, which has an HEP of about 6E-2 is dominated by errors committed during the physical alignment of the pump even though there are almost 90 minutes available to recover from any problems during the initial alignment. The need for the action could be avoided if the RCIC storage tank was available with long term makeup source (SAMA 3). The remaining contributors are dispersed among multiple events and no SAMAs are suggested for those small contributors.

Table F.5-1a
CPS FPIE Level 1 Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-GTR-007	1.00E+00	0.09837	ACCIDENT SEQUENCE GTR-007	This is an accident sequence tag for the general transient tree in which HPCS operates in the long term without decay heat removal followed by containment failure. Over 87% of the risk is associated with a failure of the inboard containment vent valve to operate due to adverse environmental conditions. Installing a hard pipe FLEX vent (SAMA 4) or replacing the valve with one that can function in adverse conditions (SAMA 8) are options to mitigate these scenarios.
1RPOPYDCLOAD-H--	6.26E-02	0.09592	DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL	This event represents the failure of the operators to perform the DC load shedding task during ELAP scenarios to ensure the DC battery life is adequate to support implementation of FLEX strategies. While the HEP is not large, there are estimated to be 20 minutes available for recover actions after performance in the event an error is made. The difficulty is finding the error with limited personnel. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed. This could support a checking process improve the reliability of the action (SAMA 2).
%FLFPMMCR	6.51E-05	0.09317	FPS FLOOD (MAJOR) IN CB-1I ABOVE MAIN CONTROL ROOM	MCR flooding is the dominant contributor to class IA scenarios at CPS. Some screening level events, such as the HFE for manual shutdown of the plant at the remote shutdown panel (RSP), if refined, may reduce the importance of these scenarios. Assuming there are no means of reducing probabilities of failing to evacuate the MCR or of controlling the plant from the RSP, physical modifications could be performed to protect the MCR from water ingress during flooding events (SAMA 6).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RIPT-FLEXAL-A--	1.00E-01	0.09219	RCIC FAILS AFTER FLEX REALIGNMENT	The current FLEX strategy requires RCIC to be aligned to the RHR system as a long term, cool suction source because the RCIC storage tank is not protected against credible hazards that could lead to ELAP scenarios. This event represents a "lumped" set of failures for the FLEX strategy and is not necessarily specific to problems using RCIC with RHR as the suction source. However, if the RCIC storage tank is protected and a makeup source is provided, it could be used as an indefinite cool suction source for RCIC and provide an additional success path for long term loss of heat removal scenarios (SAMA 3).
1RHRXDHRRECLTH--	4.33E-01	0.08469	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	This is a data-based event and no specific insight has been identified related to RHR repair apart from that when RHR is not available, and alternate means of heat removal is required, which can also be accomplished with SAMA 4. SAMA 8 also provides a means of mitigating about 25% of the risk from these scenarios.
1DGDG-DGABC--XCC	4.59E-05	0.07913	DG A B AND C FAIL TO RUN - CC	This event represents common cause failure of the 3 emergency diesel generators. 65% are long term SBO events in which RCIC initially runs. There are multiple large contributors, including failure of the load shed action at about 20%. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed. This could support a checking process improve the reliability of the action (SAMA 2). About 19% is related to the failure of RCIC after alignment to the RHR heat exchanger outlet, which is addressed by SAMA 3 (protected RCIC storage tank with long term makeup). An additional 14% of the risk is related to the failure to realign the buses after successful recovery of offsite power. Installation of an emergency line from the

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				offsite source to the plant buses powering mitigating equipment could reduce the probability related to alignment failures (SAMA 5).
1APRX-OSP-RX-H--	1.00E+00	0.07625	RX: OP FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RECOVERY OF OSP	This event represents the failure to align power from the offsite source to the plant buses in time to prevent core damage. Installation of an emergency line from the offsite source to the plant buses powering mitigating equipment could reduce the probability related to alignment failures (SAMA 5).
1APRXOSP6HRSYH--	2.09E-01	0.07035	FAILURE TO RECOVER OSP WITHIN 6 HOURS (SWYD LOOP EVENT)	This event represents the failure to recover offsite power within 6 hours given that it was caused by a switchyard failure. These are longer term LOOP event for which RCIC initially runs. Almost 30% include failure of RCIC to run after alignment to the RHR Hx output as part of the FLEX strategy, which is addressed by providing a protected RCIC storage tank (SAMA 3). An additional 21% are related to common cause DG HVAC fan failures, which can be mitigated by the use of portable HVAC equipment (SAMA 1). A further 18% of the contribution is related to the failure to align the FLEX pump to cool the RHR heat exchangers. This action, which has an HEP of about 6E-2 is dominated by errors committed during the physical alignment of the pump even though there are almost 90 minutes available to recover from any problems during the initial alignment. Protecting the RCIC storage tank and ensuring it has adequate volume for long term RCIC operation would provide an alternate means of maintaining core cooling when combined with containment venting (SAMA 3). The remaining contributors are dispersed among multiple events and no SAMAs are suggested for those small contributors.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APSYLOOPIEGRF--	2.00E-01	0.06759	COND. PROBABILITY LOOP DUE TO GRID RELATED EVENT	Similar to event 1APSYLOOPIESWF--, this is the fractional contribution of LOOP events that are power grid-related. The contributors include failure of RCIC after alignment of the suction to RHR in ELAP scenarios, failure of DC load shedding, and failure of EDG Room HVAC fans. These contributors are addressed by SAMAs 3, 2, and 1, respectively. Additional contributors include common cause EDG failures. While providing an additional 4KV EDG is not likely to greatly mitigate these common cause failures, protecting the RCIC storage tank and providing a makeup source such that RPV injection does not rely on suppression pool cooling would reduce the risk of the scenarios that include EDG failures (SAMA 3).
%TT	6.58E-01	0.06749	TURBINE TRIP WITH BYPASS INITIATOR	For turbine trip initiating events, the contributors are dispersed among multiple smaller contributors, including failure to bypass the MSIV closure low level interlock (16.5%), the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) (14.9%), failure to recover RHR with success of the upper pool dump (13.8%), and catastrophic failure of containment (due to overpressure) (13%). Potential plant enhancements to address these issues include Installing a keylock switch to bypass the MSIV low level isolation logic (SAMA 9) and providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of providing additional vent capability (SAMA 4).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXOSP6HRGRH--	3.08E-01	0.06178	FAILURE TO RECOVER OSP WITHIN 6 HOURS (GRID RELATED LOOP EVENT)	This event represents the failure to recover offsite power within 6 hours given that it was caused by a grid-related issue. These are longer term LOOP event for which RCIC initially runs. Almost 30% include failure of RCIC to run after alignment to the RHR Hx output as part of the FLEX strategy, which is addressed by providing a protected RCIC storage tank (SAMA 3). An additional 22% are related to common cause DG HVAC fan failures, which can be mitigated by the use of portable HVAC equipment (SAMA 1). A further 18% of the contribution is related to the failure to align the FLEX pump to cool the RHR heat exchangers. This action, which has an HEP of about 6E-2 is dominated by errors committed during the physical alignment of the pump even though there are almost 90 minutes available to recover from any problems during the initial alignment. Protecting the RCIC storage tank and ensuring it has adequate volume for long term RCIC operation would provide an alternate means of maintaining core cooling when combined with containment venting (SAMA 3). The remaining contributors are dispersed among multiple events and no SAMAs are suggested for those small contributors.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1DGDG-DG01KA-X--	1.02E-02	0.0603	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	This event represents the failure to run of EDG 1KA. About 18% of the contribution is from scenarios in which DC load shedding fails. This action could potentially be made more reliable if a procedure step is included in the procedure to check that the current load on the batteries is within the expected/acceptable range after completion of the action (SAMA 2). A further 18% of the contribution is related to the failure to align the FLEX pump to cool the RHR heat exchangers. This action, which has an HEP of about 6E-2 is dominated by errors committed during the physical alignment of the pump even though there are almost 90 minutes available to recover from any problems during the initial alignment. The need for the action could be avoided if the RCIC storage tank was available with a long-term makeup source, and implementing SAMA 3 is means of mitigating this risk. About 15% of the contribution is related to the failure to align the plant buses after recovery of offsite power. Installation of an emergency line from the offsite source to the plant buses powering mitigating equipment could reduce the probability related to alignment failures (SAMA 5). About 13% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1DGDG-DG01KB-X--	1.02E-02	0.05292	FAILURE OF DIESEL GENERATOR 01KB TO RUN	This event represents the failure to run of EDG 1KB. About 18% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4). A further 17% of the contribution is related to the failure to align the FLEX pump to cool the RHR heat exchangers. This action, which has an HEP of about 6E-2 is dominated by errors committed during the physical alignment of the pump even though there are almost 90 minutes available to recover from any problems during the initial alignment. The need for the action could be avoided if the RCIC storage tank was available with a long-term makeup source, and implementing SAMA 3 is means of mitigating this risk. About 17% of the contribution is from scenarios in which DC load shedding fails. This action could potentially be made more reliable if a procedure step is included in the procedure to check that the current load on the batteries is within the expected/acceptable range after completion of the action (SAMA 2). About 15% of the contribution is related to the failure to align the plant buses after recovery of offsite power. Installation of an emergency line from the offsite source to the plant buses powering mitigating equipment could reduce the probability related to alignment failures (SAMA 5).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1--SYAVAILFAC---	9.53E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
FLG-IE-LOOP	1.00E+00	4.98E-01	FLAG - FIRE IE LOOP	This is a flag marking fire induced LOOP events. The top contributing sequences cover the range of failure scenarios related to the high-pressure injection systems: LOOP-053 (40%) in which HPCS is initially successful, LOOP-092 (24%) in which RCIC operates in the short term successfully, and LOOP-099 (24%), where all high pressure injection systems fail early. Because of the diverse range of scenarios covered, there are not any single SAMAs that address all risk contributors, but failure to load shed is present in nearly 30% of the contributors that include this event. A potential enhancement to reduce the risk related to these failures would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). In other cases, the fire protection system would potentially be available to provide makeup, but because of the long alignment time and limited flow rate for RPV injection, it is not credited. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the risk from these scenarios (SAMA 10). In addition, protecting some of the cables that are damaged in fires that lead to LOOP could be protected (SAMA 14). Finally, improving the ability to quickly align offsite power from the switchyard to the emergency buses could reduce the risk of some scenarios (SAMA 5).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CVPH-SMALLD-F--	1.00E+00	3.84E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	This event identifies that the small diameter vent paths are not a viable venting mechanism and no credit is taken for use of those paths. It is combined with failures of the credited vent path, which is dominated by failure of the in-containment vent path AOV failing to open due to environmental stress. Providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of addressing this risk (SAMA 8).
RCVCL-2A	1.00E+00	3.28E-01	ACCIDENT CLASS IIA	This is the Accident Class 2A (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure). The dominant contributor (>99%) is the inability of the small diameter vent paths to provide venting capabilities (see 1CVPH-SMALLD-F-- for details). Therefore, there are no additional SAMAs identified for this event.
1RHRXDHRRECLTH--	1.00E+00	2.64E-01	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	The RHR recovery failure event is set to 1.0 for fire-induced failure of RHR equipment (no credit taken for recovery of RHR system given fire-induced failures). No specific insights have been identified related to this event.
1DGRXDGREC30MH--	1.00E+00	2.60E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	The DG recovery failure event is set to 1.0 (no credit taken for recovery of a failed diesel generator). No specific insights have been identified related to this event, though the same SAMAs that were identified for Accident Classes 1BE and 1BL would be applicable.
1APRXOSP20HPCH--	1.00E+00	2.39E-01	FAILURE TO RECOVER OSP WITHIN 20 HOURS (PLANT CENTERED LOOP EVENT)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). No specific insights have been identified related to this event, though the same SAMAs that were identified for basic events RCVCL-1BE and RCVCL-1BL (station blackouts accident class) would be applicable.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-1BE	1.00E+00	2.33E-01	ACCIDENT CLASS IBE	This is the Accident Class IBE flag (station blackout, early). Approximately 47% of the Class IBE contributors include a failure to perform the DC load shed action (see 1RPOPYDCLOAD-H-F for details). Additionally, random failure of the EDGs (including common cause failures) are significant contributors. Since common cause failure is a major contributor to EDG unavailability, an additional EDG is not suggested as a SAMA to address the risk because the new EDG would be added to the same common cause group as the existing EDGs. Finally, the SAMAs identified for basic event FLG-IE-LOOP would also apply as protection of offsite power from fire-induced failures would reduce the contribution of Accident Class 1BE.
RCVSEQ-LOOP-099	1.00E+00	2.30E-01	ACCIDENT SEQUENCE LOOP-099	This is the accident sequence LOOP-099 flag. This is Accident Class 1BE (station blackout, early) and the SAMAs discussed to address the risk from event RCVCL-1BE are applicable to this event.
FLG-IE-TT	1.00E+00	2.14E-01	FLAG - FIRE IE TT	This is a flag that indicates that the default initiating event used for the fire PRA is a turbine trip when a more severe initiating event does not apply (i.e., all postulated fire scenarios result in a turbine trip at a minimum). No specific insights have been identified related to this event.
FIRE-TT	1.00E+00	2.14E-01	FIRE INDUCED TURBINE TRIP	This is a flag that indicates that the default initiating event used for the fire PRA is a turbine trip when a more severe initiating event does not apply (i.e., all postulated fire scenarios result in a turbine trip at a minimum). No specific insights have been identified related to this event.
RCVSEQ-LOOP-053	1.00E+00	2.06E-01	ACCIDENT SEQUENCE LOOP-053	This is the accident sequence LOOP-053 flag. This is Accident Class 2A (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure) and the SAMAs discussed to address the risk from event RCVCL-2A are applicable to this event.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-1BL	1.00E+00	1.59E-01	ACCIDENT CLASS IBL	This is the Accident Class IBL flag (station blackout, late). Approximately 48% of the Class 1BL contributors include a failure to locally open RAT/ERAT circuit breakers given they failed to automatically open (see 1SYOPCB201221H-F for details). Additionally, random failure of the EDGs (including common cause failures) are significant contributors. Since common cause failure is a major contributor to EDG unavailability, an additional EDG is not suggested as a SAMA to address the risk because the new EDG would be added to the same common cause group as the existing EDGs. Finally, the SAMAs identified for basic event FLG-IE-LOOP would also apply as protection of offsite power from fire-induced failures would reduce the contribution of Accident Class 1BE.
1SMSY-SUCC---F--	9.90E-01	1.49E-01	SUCCESS OF UPPER POOL DUMP	This event represents the successful transfer of the upper pool inventory to the lower pool (provides more time to reach adverse containment conditions). Approximately 73% are Class 2A scenarios, which are addressed by the SAMAs discussed for the RCVCL-2A event. An additional 9% are Class 2V scenarios, which include successful containment vent followed by injection failure. A dominant contributor to the Class 2V scenarios is the failure to control the containment vent process to maintain NPSH for the pumps taking suction from the suppression pool. Currently, the CPS procedures do not provide specific guidance for controlling venting to preserve injection pump operation and operator training does not extend to long term scenarios to provide detailed practice on this action. A potential enhancement would be to include guidance in the EOPs related to controlling vent pressure to maintain NPSH and to include this action in the training program (SAMA 7). In addition, the probability of failing to properly align an adequate containment venting path is a significant contributor venting failure. Providing a pathway that is straightforward to use, is operable under adverse conditions without support systems, and having

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				directions the clearly direct selection of the vent path would improve reliability (SAMA 4).
RCVCL-1A	1.00E+00	1.45E-01	ACCIDENT CLASS IA	This is the Accident Class 1A flag (loss of inventory makeup while at high pressure). Approximately 66% of the Class 1A contributors are associated with main control room (MCR) fires that result in MCR abandonment and operators utilize the remote shutdown panel (RSP). The need to abandon the control room given a fire in the MCR would be obvious and RSP actions are proceduralized. Therefore, no specific insights have been identified related to this event.
1SYRXCB201221H-F	1.00E+00	1.43E-01	RX: OP FAILS TO OPEN RAT/ERAT CB 201 OR CB 221 (FIRE VERSION)	This event is used as a flag when the human failure event (HFE) is used in a dependent group of HFEs (i.e., basic events "FDEPGROUP*"). Basic event 1SYOPCB201221H-F is replaced with 1SYRXCB201221H-F which has a 1.0 value to provide information as to the contributors to the dependent group. See discussion for event 1SYOPCB201221H-F.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXOSP6HRPCH--	1.00E+00	1.40E-01	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED LOOP EVENT)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). No specific insights have been identified related to this event, though the same SAMAs that were identified for basic events RCVCL-1BE and RCVCL-1BL (station blackouts accident class) would be applicable.
RCVSEQ-LOOP-092	1.00E+00	1.40E-01	ACCIDENT SEQUENCE LOOP-092	This is the accident sequence LOOP-092 flag. This is Accident Class 1BL (station blackout, late) and the SAMAs discussed to address the risk from event RCVCL-1BL are applicable to this event. It is noted that accident sequence LOOP-092 includes RPV depressurization failure and the model conservatively does not credit the FLEX diesel generators providing SRV DC control power. Energizing the Div 1 (or Swing) Battery Charger and supplying DC MCC 1A with the FLEX diesel generator is proceduralized and loss of control power to the SRVs would be mitigated by existing capabilities.
1RHRX-REC-UPDH--	1.00E+00	1.38E-01	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	The RHR recovery failure event is set to 1.0 for fire-induced failure of RHR equipment (no credit taken for recovery of RHR system given fire-induced failures). No specific insights have been identified related to this event.
1RPRXYDCLOAD-H-F	1.00E+00	1.30E-01	RX: DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL (FIRE VERSION)	This event is used as a flag when the human failure event (HFE) is used in a dependent group of HFEs (i.e., basic events "FDEPGROUP*"). Basic event 1RPOPYDCLOAD-H-F is replaced with 1RPRXYDCLOAD-H-F which has a 1.0 value to provide information as to the contributors to the dependent group. See discussion for event 1RPOPYDCLOAD-H-F.
1CTSYLRGPCFLLR--	2.00E-01	1.25E-01	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability of a severe containment failure after overpressure in loss of containment heat removal scenarios. Over 99% include the event marking the inability of the smaller diameter vent paths being unable to adequately reduce containment pressure (see 1CVPH-SMALLD-F-- for details).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXOSP2HRPCH--	1.00E+00	1.21E-01	FAILURE TO RECOVER OSP WITHIN 2 HOURS (PLANT CENTERED LOOP EVENT)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). No specific insights have been identified related to this event, though the same SAMAs that were identified for basic events RCVCL-1BE and RCVCL-1BL (station blackouts accident class) would be applicable.
1CTSYSTEAMBIND--	2.04E-01	1.19E-01	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	This event represents the likelihood of steam binding of the ECCS pumps taking suction off the suppression pool following containment failure. This is a data-based event and approximately 37% of its contribution is related to failure of the onsite diesel generators. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators. Additionally, approximately 18% of its contribution is related to failure of ECCS room cooling (e.g., RHR room coolers). A potential plant enhancement to address this is to provide portable ECCS room HVAC equipment and to develop procedures that would direct their use in any scenarios in which other means of ECCS room cooling have failed (SAMA 13).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTSY-WWLOSS-R--	2.00E-01	1.16E-01	WW RUPTURE CAUSES LOSS OF WATER IN POOL	This event represents the likelihood of a catastrophic containment rupture due to a failure in the wetwell water space. This is a data-based event and approximately 37% of its contribution is related to failure of the onsite diesel generators. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators. Additionally, approximately 18% of its contribution is related to failure of ECCS room cooling (e.g., RHR room coolers). A potential plant enhancement to address this is to provide portable ECCS room HVAC equipment and to develop procedures that would direct their use in any scenarios in which other means of ECCS room cooling have failed (SAMA 13).
FLG-IE-MCR	1.00E+00	1.16E-01	FLAG - FIRE IE MCR ABANDONMENT	This is a flag that indicates main control room (MCR) abandonment due to fire-induced loss of habitability or loss of control. The SAMAs discussed to address the risk from event RCVCL-1A are applicable to this event.
1DGDG-DG01KB-X--	3.07E-02	1.13E-01	FAILURE OF DIESEL GENERATOR 01KB TO RUN	This event represents the failure to run of EDG 1B. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators.
FDEPGROUP-COMB013	3.91E-02	1.06E-01	FIRE HEP DEPENDENCY GROUP 013	This event represents failure of multiple HFEs that reflects the potential dependencies between the HFEs. Specifically, this group analyzes failure to perform DC load shed (1RPOPYDCLOAD-H-F) and failure to open RAT/ERAT circuit breakers (1SYOPCB201221H-F). No specific insights have been identified related to this event, though the same SAMAs that were identified for the individual HFEs would be applicable.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
F-CB-D2-HS	6.00E-01	1.05E-01	CIRCUIT BREAKER (DIV 2) HOT SHORT PROBABILITY	This is a conditional hot short probability event given fire-induced cable damage that prevents the RAT/ERAT circuit breakers from opening. This event is related to action 1SYOPCB201221H-F, so the SAMAs identified for that operator action would apply to this hot short probability (i.e., action 1SYOPCB201221H-F is taken in response to fire-induced cable damage). Additionally, installing 3-hour rated fire cable wrap on the cables that could prevent the circuit breakers from opening throughout their entire cable routing (SAMA 14) would reduce fire CDF risk by approximately 10%.
F-CB-D1-HS	6.00E-01	1.05E-01	CIRCUIT BREAKER (DIV 1) HOT SHORT PROBABILITY	This is a conditional hot short probability event given fire-induced cable damage that prevents the RAT/ERAT circuit breakers from opening. This event is related to action 1SYOPCB201221H-F, so the SAMAs identified for that operator action would apply to this hot short probability (i.e., action 1SYOPCB201221H-F is taken in response to fire-induced cable damage). Additionally, installing 3-hour rated fire cable wrap on the cables that could prevent the circuit breakers from opening throughout their entire cable routing (SAMA 14) would reduce fire CDF risk by approximately 10%.
1SYOPCB201221H-F	3.74E-02	1.03E-01	OPERATOR FAILS TO OPEN RAT/ERAT CB 201 OR CB 221	This event represents the failure of the operators to locally open RAT/ERAT circuit breakers that did not automatically open given a loss of an offsite power source. Failure of these circuit breakers to open would prevent the EDG circuit breakers from closing. This action is performed locally in the EDG rooms on the local control panel. The operator would have clear indication of loss of normal power and failure of the EDGs to auto start by the loss of power to the emergency bus. If power is lost, the operators are instructed by EOPs (i.e., EOP-1) to restore power by manually starting the EDGs. The compelling signal would be loss of lighting in the control room plus the lack of voltage on the emergency bus, which occurs at the time of the loss of power event. The action is a routine part of operating crew training and therefore, it has a high probability of success that they would follow through on the

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				action during an actual loss of power event. Therefore, no specific insights have been identified related to this event.
1DGDG-DG01KA-X--	3.07E-02	1.01E-01	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	This event represents the failure to run of EDG 1A. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators.
1FPOPALIGN-FPH-F	1.00E+00	9.45E-02	OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION	A number of alternate injection sources are available given loss of primary injection systems (i.e., feedwater, RCIC, HPCS, LPCS, LPCI). One alternate system is fire water injection via RHR B. This action requires operators to align fire water to RHR B following removal of the internals of one check valve in order to permit required flow. Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APOP-OSP30M-H--	1.00E+00	8.62E-02	OPERATOR FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RX OF OSP WITHIN 30 MINS	This event represents failure to realign AC buses to offsite power following successfully recovering the initial offsite power within 30 minutes. Due to the number of actions that need to be performed and the short time frame, this action is not credited. Installing an emergency tie line that simplifies the process of restoring power to an emergency bus (SAMA 5) could potentially reduce the risk from scenarios containing this action.
1SXOP-RXSWINJH-F	1.00E+00	8.51E-02	OPERATOR FAILS TO INITIATE SX INJECTION THROUGH RHR DISCHARGE LINE B - FIRE PRA	This human failure event (HFE) is not credited in the Fire PRA due to insufficient timing. Therefore, no specific insights have been identified related to this event.
RCVSEQ-GTR-024	1.00E+00	7.84E-02	ACCIDENT SEQUENCE GTR-024	This is the accident sequence GTR-024 flag. This is Accident Class 2A (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure) and the SAMAs discussed to address the risk from event RCVCL-2A are applicable to this event.
%F_T-1H_1TO02S_O_W	1.37E-04	7.59E-02	Fire at Seal Oil Unit 1TO02S (Severe) - Undeveloped - Initiator	This fire initiating event represents a conservative oil fire at the seal oil unit in the Turbine Building that fails all equipment and cables within the Turbine Building fire zone. Additional fire modeling for this oil fire would greatly reduce the risk-significance of this fire scenario. Refer to Section F.7.4 for additional information on the sensitivity case developed to demonstrate that no SAMAs are required to address this event.
RCVSEQ-MCR-004	1.00E+00	6.84E-02	ACCIDENT SEQUENCE MCR-004	This is the accident sequence MCR-004 flag. This is Accident Class 1A (loss of inventory makeup while at high pressure) and the SAMAs discussed to address the risk from event RCVCL-1A are applicable to this event.
RCVCL-2T	1.00E+00	5.75E-02	ACCIDENT CLASS IIT	This is the Accident Class 2T (loss of containment heat removal with the RPV initially intact; core damage induced post containment high containment pressure). The dominant contributor (>62%) is the inability of the small diameter vent

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				paths to provide venting capabilities (see 1CVPH-SMALLD-F-- for details). Therefore, there are no additional SAMAs identified for this event.
1CVMV-FAILOP-F--	1.00E+00	5.17E-02	MOTOR OPERATED VALVE FC007 CLOSES	This event represents a flag indicating that MOV 1FC007 has closed due to a loss of power. Therefore, the SAMAs that have been identified for loss of offsite power would also apply to this event.

Table F.5-2a
CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1--SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RCVCL-H/L	1.00E+00	0.86738	ACCIDENT SEQUENCE H/L	This is a flag that identifies the "High-Late" release category. About 87% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. About 13% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). About 63% of the contribution is associated with sequence LOOP-092 in which the RPV depressurization function has failed. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.
%LOOP	2.87E-02	0.78612	LOSS OF OFFSITE POWER INITIATOR	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CVPH-SMALLD-F--	1.00E+00	0.76201	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Importance Review.
RXF	1.00E+00	0.56771	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. About 70% of the scenarios with RX failure include the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 20% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8).
RCVCL-1BL	1.00E+00	0.55388	ACCIDENT CLASS IBL	Addressed in the Level 1 Importance Review.
RCVSEQ-LOOP-092	1.00E+00	0.55153	ACCIDENT SEQUENCE LOOP-092	Addressed in the Level 1 Importance Review.
1DGRXDGREC30MH--	1.00E+00	0.4109	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-OP5-NOTFSU	6.90E-01	0.40273	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBL)	This event represents the probability that the RPV is successfully depressurized before RPV breach in the Level 2 model for accident class IBL sequences. Over 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails. Over 87% of the class IIA scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path, which occurs after core damage and leads to a High-Late release. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1HRSY-RHRCN--F--	1.00E+00	0.39335	CONTINGENCY METHODS INADEQUATE (NOT CREDITED)	This event represents the unavailability of other containment heat removal methods due to lack of procedures or capacity. Over 93% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strrategy fails and RPV depressurization fails. For about 30% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.

Table F.5-2a
CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1MCHU-PCSUNAVH--	1.00E+00	0.39335	PCS UNAVAILABLE AS HEAT SINK	This event is a flag event representing the unavailability of the main condenser as a heat sink. Over 93% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 30% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1APSYLOOPIESWF--	2.40E-01	0.37161	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1SIPH-SI4-NOTFSU	6.50E-01	0.36227	AC POWER SUCC. RECOVERED DURING SI TIME FRAME (CLASS IBL)	This event represents the probability that AC power is recovered in time to prevent drywell shell melt-through (AC power recovery is assumed to result in success on at least one injection system capable of providing adequate drywell injection). About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 30% of the contributors, RCIC does not restart and function, as required, after aligning it to use the RHR system as the suction source. For about 30% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTSY-WWLOSS-R--	2.00E-01	0.31192	WW RUPTURE CAUSES LOSS OF WATER IN POOL	This event represents the probability that a rupture occurs in the wetwell below the waterline that leads to loss of wetwell inventory. About 90% of the scenarios with RX failure include the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 35% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). The remaining vent failures are related to loss of power to a containment vent valve that is assumed to be isolated as part of normal processes early in the event (i.e., credit is not taken for the valve "failing open" to support venting) and failure of the operator to perform the venting action. The vent valve failure can be mitigated by the installation of an alternate vent path (SAMA 8), which could also reduce the venting failure probability due to its simplified design.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-2A	1.00E+00	0.29077	ACCIDENT CLASS IIA	This is an accident sequence flag event that identifies loss of containment heat removal scenarios. Over 99% of the class IIA scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process (18%). About 39% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8).
1APRXOSP6HRSWH--	5.47E-01	0.29068	FAILURE TO RECOVER OSP WITHIN 6 HOURS (WEATHER RELATED LOOP EVENT)	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
B--OPDHR-EAL1F--	9.50E-01	0.28692	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the successful declaration of a general emergency in time to evacuate the population from the emergency protection zone in long term loss of decay heat removal cases before a significant release occurs (cases in which this action fails lead to "early" releases). Improving the reliability of this action would result in an increase to the risk of the associated scenarios and no such SAMAs are suggested here. Over 99% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. About 38% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Many of the remaining contributors include scenarios in which depressurization and/or low pressure injection fail, but most could be mitigated by the existing, unmodeled capability to depressurize and use low pressure injection form either a FLEX pump or the fire protection system. No additional SAMAs are proposed to address these scenarios.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-OP6-NOTFSU	9.20E-01	0.26548	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	This event represents the successful depressurization after core damage. The contributors leading to sequences that include scenarios in which depressurization before core damage was not needed (high pressure injection functioned until containment failure followed by loss of injection). Over 99% of the scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 42% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). About 42% of the contribution includes catastrophic containment failure that fails the injection paths of the RPV injection systems. Preventing containment failure via the SAMAs proposed above are also effective means of reducing the risk of these scenarios. Over 15% of the contributors include failure of the operator to perform the venting action. Again, installation of a simplified, FLEX-like hardened vent system would reduce the probability of the failure of the venting action (SAMA 4).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-IBL-048	1.00E+00	0.2644	ACCIDENT SEQUENCE IBL-048	This event is a Level 2 model accident sequence tag. The sequence includes a depressurized RPV before vessel breach, but failure to prevent vessel breach and while there is no drywell shell melt-through, a drywell isolation failure does occur. Suppression pool cooling and containment venting fail. About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 33% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXL26HRSW-H--	8.09E-01	0.24211	COND PROB OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored within 6 hours to support depressurization and injection to prevent RPV breach for switchyard related LOOP events. About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 33% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1VDFNVD01CABCXCC	5.85E-05	0.22792	FANS VD01CA B AND C FAIL TO RUN - CC	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPAD-ALTRNT-F--	1.00E+00	0.2256	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). The dominant conditions that include this event are loss of offsite power with a failure of one or more EDGs to power the battery chargers to support long term operation of the SRVs. The CPS FLEX strategy includes the alignment of the 480V battery chargers to support the SRVs, but it is conservatively not modeled for the relevant sequences. If the FLEX power alignment were to be included, these contributors would be significantly reduced and additional SAMAs would not be required (e.g., sequence LOOP-092 is a 67% contributor and RCIC operates successfully early, and LOOP-053 is a 10% contributor and HPCS operates successfully). For about 25% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-PRESBK-F--	8.00E-01	0.2256	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not cause by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	5.50E-01	0.2256	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	7.00E-01	0.2256	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1RIPT-FLEXAL-A--	1.00E-01	0.21719	RCIC FAILS AFTER FLEX REALIGNMENT	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-II-030	1.00E+00	0.18869	ACCIDENT SEQUENCE II-030	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is below the waterline (non-scrubbed release), a depressurized RPV, and a failure to prevent RPV breach. Over 90% of the risk comes from Level 1 scenarios in which high pressure RPV makeup is successful, but containment heat removal systems and containment venting fail, followed by failure of injection after containment failure. Other containment venting failure causes include failures of the inboard vent valve due to environmental stress (57), failure of the operator to perform the venting action (20%), and loss of power to the vent valves and/or air systems after an assumed closure of containment isolation valves (22%). These contributors can be mitigated by replacing the inboard containment vent valve with one that is qualified to operate in adverse conditions (SAMA 8), providing a flex-like hardened containment vent that is straightforward to use (SAMA 4), and providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
1RHRX-REC-UPDH--	2.43E-01	0.18236	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	Addressed in the Level 1 Importance Review.
1SMSY-SUCC---F--	9.90E-01	0.18236	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1DGDG-DGABC--XCC	4.59E-05	0.17784	DG A B AND C FAIL TO RUN - CC	Addressed in the Level 1 Importance Review.
1CXPH-H2-DEFGF--	1.00E+00	0.16052	HYDROGEN DEFLAGRATION OCCURS GLOBALLY	The event represents the assumption that hydrogen deflagration occurs after core damage. It is assumed that sufficient hydrogen is generated to lead to deflagration if an ignition source is present, and when the burn occurs, there is a potential for containment failure to occur. Long term station blackout represents about 57% of the risk associated with this event, and for these cases, the FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the remaining cases, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1CXPH-H2INVENF--	1.00E+00	0.16052	SUFFICIENT HYDROGEN GENERATED TO CAUSE OVERPRESSURE	The event represents the assumption that a hydrogen deflagration will result in containment overpressure if it occurs. When an overpressure event occurs, there is a potential for containment failure to occur. Long term station blackout represents about 57% of the risk associated with this event, and for these cases, the FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the remaining

Table F.5-2a
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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				cases, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1CXPH-STEAM--F--	9.00E-01	0.16052	CONTAINMENT NOT INERTED BY STEAM	The event represents the assumption that the containment is not inerted by steam such that hydrogen deflagration may occur when sufficient hydrogen for deflagration exists and an ignition source is present. When a deflagration event occurs, there is a potential for containment failure to occur due to overpressure. Long term station blackout represents about 74% of the risk associated with this event, and for these cases, the FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the remaining cases, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CZPH-DWFAIL-F--	9.00E-01	0.16052	CONDITIONAL PROBABILITY DRYWELL FAILS GIVEN DEFLAGRATION	The event represents the probability that the drywell will fail given that a hydrogen deflagration occurs after core damage. Long term station blackout represents about 74% of the risk associated with this event, and for these cases, the FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the remaining cases, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1HIPH-H2IGSBOF--	2.50E-01	0.15518	RANDOM HYDROGEN IGNITION GIVEN NO AC POWER	This event represents the probability that a random ignitions source cause hydrogen deflagration in scenarios where AC power is not available to 1) support igniter equipment that could initially prevent a hydrogen burn, and 2) are not available to serve as an ignition source. The FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the short term scenarios in which the FLEX generator may not be aligned before core damage, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CXPH-CTCOND-F--	6.60E-01	0.15247	CONDITIONAL PROBABILITY CONT. FAILS GIVEN DW FAILS	This event represents the probability that the containment fails given that a failure of the drywell has occurred. Over 92% of the contributors are related to hydrogen deflagration cases. Hydrogen deflagration occurs primarily in scenarios where AC power is not available to 1) support igniter equipment that could initially prevent a hydrogen burn, and 2) are not available to serve as an ignition source. The FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the short term scenarios in which the FLEX generator may not be aligned before core damage, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1APSYLOOPIESYF--	4.50E-01	0.14381	COND. PROBABILITY LOOP DUE TO SWYD EVENT	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CVMV-FAILOP-F--	1.00E+00	0.13648	MOTOR OPERATED VALVE FC007 CLOSES	This event is used to represent the probability that a valve in one of the containment vent paths is closed at the time venting is required. It would normally be isolated early in the accident scenario and no credit is taken for the valve being left open in the even that motive power to the valve is lost (i.e., if motive power is lost, the valve is closed and cannot be opened for the containment venting function). Over 95% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
1RHRXDHRRECLTH--	4.33E-01	0.13627	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	Addressed in the Level 1 Importance Review.
RCVSEQ-LOOP-053	1.00E+00	0.13383	ACCIDENT SEQUENCE LOOP-053	This event is an accident sequence flag. The LOOP-053 sequence in one in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				be significantly reduced. Providing a FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure.
RCVCL-H/E	1.00E+00	0.13262	ACCIDENT SEQUENCE H/E	This is a flag that identifies the "High-Early" release category. About 53 percent are early SBO scenarios and LOOP-099 sequences — in these scenarios, there are no SORVs, but RCIC and HPCS fail to provide injection in the short term, manual depressurization fails, and core damage occurs. About 38% of the H/E contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). Hydrogen deflagration occurs in about 52% of the contributors, and these generally occur due to lack of power to the igniters. While some of these cases could potentially be mitigated by alignment of the FLEX generator to the supply buses, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15). Vessel breach occurs in about 94% of the scenarios, and while RPV depressurization is successful in about 70 percent of the contributors, the vessel breach

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				probability is 1.0. Providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10) and provide a viable means of RPV injection that would reduce magnitude of the releases currently included in this release category.
1CTSYLRGPCFLLR--	2.00E-01	0.12106	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability that containment failure will be large enough to cause enough damage to fail the RPV injection systems. By definition, the scenarios include failure of containment heat removal/containment venting, 57% of which are related to failure of the inboard containment vent valve due to adverse containment conditions. About 30% include loss of power to the containment vent valve after it was assumed to close as part of the isolation function early in the scenario. Installing a FLEX-like hard-piped vent (SAMA 4) or replacing the inboard containment vent with a valve qualified to

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				operate in adverse conditions (SAMA 9) could reduce the risk from these scenarios. Over 11% of the contributors include operator failure to vent, which could potentially be reduced by the installation of a vent path with a simplified venting process (SAMA 4).
1APRX-OSP-RX-H--	1.00E+00	0.11573	RX: OP FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RECOVERY OF OSP	Addressed in the Level 1 Importance Review.
1CVPH-TEMPF—F--	1.00E-02	0.11281	IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1)	Addressed in the Level 1 Importance Review.
1APRXOSP6HRSYH--	2.09E-01	0.11182	FAILURE TO RECOVER OSP WITHIN 6 HOURS (SWYD LOOP EVENT)	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1FXOP-RECOVPDH--	6.36E-02	0.11024	OP ACT: FAILURE TO RECOVER w/ PRI DD P FAILED	Sequence LOOP-092 is a 91% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10).
1CZPH-CZ4-NOTFSU	4.10E-01	0.09333	HIGH PRESSURE BLOWDOWN DOES NOT OVERWHELM VAPOR SUPPRESSION	The event is used in the event tree sequences to quantitatively adjust the probability of the sequences in which the CZ (energetic containment failure) does not occur. Because the CZ failure probability is large, the assumption that the success path probability can be approximated as 1.0 is not justified and this event is used to address the issue. About 93% of the scenarios are LOOP-092 sequences in which RCIC runs initially, but fails to provide long term injection, other HPI sources are not available, RPV depressurization fails and core damage occurs. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				for the H/L scenarios. No additional SAMAs suggested.
1APRXL220HRSWH--	3.57E-01	0.09095	COND PROB OF FAILURE TO RESTORE AC IN L2 WITHIN 20.5 HRS. NODE SI	This event represents the conditional failure to recover offsite power by 20.5 hours to support injection to prevent drywell failure after core damage. Over 99% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.
RCVSEQ-GTR-007	1.00E+00	0.08975	ACCIDENT SEQUENCE GTR-007	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXL26HRSY-H--	5.74E-01	0.08752	COND PROB OF FAILURE TO RESTORE AC IN L2 W/IN 6 HRS. IN NODE OP, RX	This event represents the conditional failure to recover offsite power by 6 hours to support injection to prevent RPV breach after core damage. Over 99% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTPH-WW-NOT-F--	8.00E-01	0.08732	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	This event represents the probability that when containment overpressure failure occurs that the break will be above the torus water level line, which leads to release from the suppression pool that have passed through the water volume and have been “scrubbed”. For loss of containment heat removal, failure of venting capability is, as in other scenarios, addressed by SAMAs 4 and 8. Over 96% of the contribution includes initial early isolation of a containment vent valve with subsequent loss of power to the value, leading to the inability to open it, which could be mitigated with SAMA 4. Catastrophic containment failure, which fails the RPV injection paths, is a 40% contributor, but in other cases, steam binding of pumps and failure to align fire protection for injection are contributors. Fire protection injection is conservatively assumed not to be available due to lengthy alignment times, but for these scenarios, this is conservative and the existing hardware and procedures would support injection and core damage could potentially be prevented. No SAMAs would necessarily be required to address these scenarios, however, providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10). About 40% of the contributors are related to loss of the RHR and Core Spray pumps due to steam binding after rapid containment depressurization. Additional training and procedure enhancements on managing NPSH

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				during the venting process may reduce the risk of this scenario (SAMA 7).
1APSYLOOPIEGRF--	2.00E-01	0.08643	COND. PROBABILITY LOOP DUE TO GRID RELATED EVENT	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-IBL-051	1.00E+00	0.08126	ACCIDENT SEQUENCE IBL-051	This event is a Level 2 model accident sequence tag. The sequence is a long term SBO scenario that includes success of RPV depressurization, RPV breach, no energetic failure of the DW, no energetic failure of containment, successful containment isolation, DW shell failure, failure of containment vent. 100% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. Providing a FLEX-like containment vent that is capable of operating without support systems would reduce the risk of containment failure (SAMA 4). Providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10) and provide a means of RPV makeup once the RPV is depressurized.
1APRXOSP6HRGRH--	3.08E-01	0.07451	FAILURE TO RECOVER OSP WITHIN 6 HOURS (GRID RELATED LOOP EVENT)	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-IBL2-022	1.00E+00	0.07214	ACCIDENT SEQUENCE IBL2-022	This event is a Level 2 model accident sequence tag. The sequence is a long term SBO scenario that includes failure of RPV depressurization, RPV breach, no energetic failure of the DW, no energetic failure of containment, successful containment isolation, DW shell failure, failure of SPC, failure of containment vent. 100% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. Providing a FLEX-like hardened containment vent that is capable of operating without support systems would reduce the risk of containment failure (SAMA 4). Providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10) and provide a means of RPV makeup once the RPV is depressurized.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-II-009	1.00E+00	0.07136	ACCIDENT SEQUENCE II-009	This event is an accident sequence flag. Over 97% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
RCVCL-1BE	1.00E+00	0.07004	ACCIDENT CLASS IBE	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1DGDG-DGABC—ACC	1.86E-05	0.06969	DG A B AND C FAIL TO START — CC	This event represents common cause failure of the 3 emergency diesel generators. 89% are long term SBO events in which RCIC initially runs. There are multiple large contributors, including hydrogen deflagration at about 20% and failure of the containment vent path at 74%. Providing a battery backup to the hydrogen igniters could provide a means of prolonging operation until the FLEX generator is available to support them (SAMA 15) and providing a FLEX-like hardened vent would provide a simplified, reliable means of venting without support systems (SAMA 4).
RCVSEQ-LOOP-099	1.00E+00	0.06954	ACCIDENT SEQUENCE LOOP-099	Addressed in the Level 1 Importance Review.
1DGDG-DG01KA-X--	1.02E-02	0.06242	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	Addressed in the Level 1 Importance Review.
1FXOPFLEXRISFH--	3.69E-02	0.05867	OP ACT: FAIL TO MANUALY OPEN SF SPC PATH VALVES	This event represents the probability that an operator action to align a long term FLEX injection path fails. If the RCIC storage tank were to be protected and a long term makeup supply provided, this would allow RCIC to use the storage tank in ELAP scenarios and not rely on more complex actions to align alternate injection alignments (although they could remain as backup options) (SAMA 3). 92% of the contributors are long term SBO events with over 86% including failure of the containment vent function. Providing a FLEX-like hardened containment vent that is capable of operating

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				without support systems would reduce the risk of containment failure (SAMA 4).
1FXOP-FLEXDG-H--	3.56E-02	0.05615	OP ACT: START FLEX DG AND ALIGN TO 480 VAC SUBSTATIONS	This event represents the probability that the operators will fail to align the 480V FLEX generator to the 1E or 1F busses to support the FLEX strategies during an ELAP scenario. Over 92% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.
1DGDG-DG01KB-X--	1.02E-02	0.05554	FAILURE OF DIESEL GENERATOR 01KB TO RUN	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXL26HRGR-H--	5.74E-01	0.05449	COND PROB OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored within 6 hours to support depressurization and injection to prevent RPV breach for grid centered LOOP events. About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 33% of the contributors, the FLEX strategy of aligning RCIC to RHR does not function, as required, after aligning it to use the RHR system as the suction source. For the FPIE, protection of the RCIC storage tank is likely not required and the assumed tank failure may be conservative, but the tank could be hardened/protected and a long term makeup source could be provided to ensure RPV makeup would be available without the need for SPC (SAMA 3). The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1RPOPYDCLOAD-H--	6.26E-02	0.05347	DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1—SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RXF	1.00E+00	0.99458	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The event description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successsful in the dominant contributors. Over 60% of the contributors are related to sequences in which RCIC fails, HPCS provides injection, and SPC failure leads to either venting or containment failure, after which RPV injection is lost and core damage occurs. About 43% of the venting failures are related to failure of the inboard containment vent valve due to adverse environmental conditions, which could be mitigated by preplacing the valve with one qualified for operation in adverse conditions (SAMA 8). Loss of injection after venting would still be a potential issue — if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of core damage would be reduced, and if core damage prevention failed, it may still be possible to align injection in time to prevent RPV breach (SAMA 10) (over 88% of the contributors include successful depressurization before RPV breach).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTPH-WW-NOT-F--	8.00E-01	0.80658	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	This event represents the probability that the location of the containment breach will be above the water line (leads to a scrubbed release). Generally, the pre-core damage contributors are diverse and overpressure is the result of both level/power control failures as well as failure of containment heat removal. Over 70% of the contributors are level 2 sequences in which the RPV is depressurized, RPV breach is not prevented, and the release occurs via a breach in the wetwell airspace(scrubbed). Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/L releases could potentially be reduced (SAMA 10).
1OPPH-OP6-NOTFSU	9.20E-01	0.69791	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	The event represents the probability of successfully depressurizing the RPV before RPV breach in accident class II sequences. RPV breach is currently assumed to always occur; however, injection with fire protection could potentially prevent some failures in it current configuration. Further risk reductions could be realized by providing a hard piped connection for fire protection injection (SAMA 10). However, because catastrophic containment failure occurs in about 71% of the contributors, preventing containment failure is more likely to reduce plant risk. Failure of containment venting is an 80% contributor. Installing a hard pipe FLEX vent

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				(SAMA 4) or replacing the valve with one that can function in adverse conditions (SAMA 8) are options to mitigate these scenarios.
RCVCL-M/L	1.00E+00	0.69597	ACCIDENT SEQUENCE M/L	This is the accident flag event for the medium-low release category. As with the H/L release category, a large percentage of the scenarios include failure of the containment venting function, which can be addressed by SAMAs 4 and 8. Additionally, a major characteristic of the contributors is the successful depressurization of the RPV after core damage (over 97%), but the failure to prevent RPV breach (1.0 probability). The 1.0 probability for the prevention of vessel breach is due to the fact that injection after containment failure has failed to prevent core damage, which includes the potential for depressurization to fail; hence, if depressurization failure did not occur, then all injection has failed for other reasons. About 70% of the scenarios include catastrophic containment failures that fail the RPV injection paths (SAMAs 4 and 8 address). The remaining larger contributors include failure to control containment venting to maintain NPSH or containment failures that lead

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				to steam binding of the pumps. Enhancing the venting procedure and training to manage NPSH during containment venting may reduce the risk from these scenarios. Because the fire protection system is currently not credited in these long term scenarios when alignment would likely be possible, the risk from loss of injection due to steam binding is likely over estimated and no additional SAMAs are required, though SAMA 10 could further reduce risk.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
B—OPDHR-EAL1F--	9.50E-01	0.69148	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the successful declaration of a general emergency in time to evacuate the population from the emergency protection zone in long term loss of decay heat removal cases before a significant release occurs (cases in which this action fails lead to "early" releases). Improving the reliability of this action would result in an increase to the risk of the associated scenarios and no such SAMAs are suggested here. About 80% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. About 60% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Many of the remaining contributors include scenarios in which depressurization and/or low pressure injection fail, but most could be mitigated by the existing, unmodeled capability to depressurize and use low pressure injection form either a FLEX pump or the fire protection system. No additional SAMAs are proposed to address these scenarios.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CVPH-SMALLD-F--	1.00E+00	0.57231	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Importance Review.
RCVCL-2A	1.00E+00	0.57202	ACCIDENT CLASS IIA	Addressed in the Level 1 Importance Review.
RCVL2-II-008	1.00E+00	0.5463	ACCIDENT SEQUENCE II-008	This event is a Level 2 model accident sequence tag. The sequence includes a depressurized RPV before vessel breach, but failure to prevent vessel breach with containment failure in the wetwell airspace (scrubbed release). The 1.0 probability for the prevention of vessel breach is due to the fact that injection after containment failure has failed to prevent core damage, which includes the potential for depressurization to fail; hence, if depressurization failure did not occur, then all injection has failed for other reasons. About 88% of the scenarios include catastrophic containment failures that fail the RPV injection paths (SAMAs 4 and 8 address). The around 11% of the contributors include failure of pumps taking suction from the suppression pool due to steam binding after rapid containment depressurization. Because the fire protection system is currently not credited in these long term scenarios when alignment would likely be possible, the risk from loss of injection due to steam binding is likely over estimated and no additional SAMAs are required, though SAMA 10 could further reduce risk.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RHRX-REC-UPDH--	2.43E-01	0.54477	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	Addressed in the Level 1 Importance Review.
1SMSY-SUCC---F--	9.90E-01	0.54477	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Importance Review.
1CTSYLRGPCFLLR--	2.00E-01	0.50945	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability that containment failure will be large enough to cause enough damage to fail the RPV injection systems. By definition, the scenarios include failure of containment heat removal/containment venting, 78% of which are related to failure of the inboard containment vent valve. Installing a FLEX-like hard-piped vent (SAMA 4) or replacing the inboard containment vent with a valve qualified to operate in adverse conditions (SAMA 9) could reduce the risk from these scenarios. About 19% of the contributors include operator failure to vent, which could potentially be reduced by the installation of a vent path with a simplified venting process (SAMA 4).
1CVPH-TEMPF--F--	1.00E-02	0.43659	IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1)	Addressed in the Level 1 Importance Review.
RCVSEQ-GTR-007	1.00E+00	0.38228	ACCIDENT SEQUENCE GTR-007	Addressed in the Level 1 Importance Review.
%LOOP	2.87E-02	0.3128	LOSS OF OFFSITE POWER INITIATOR	Addressed in the Level 1 Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-M/E	1.00E+00	0.30403	ACCIDENT SEQUENCE M/E	This is a flag that identifies the "Medium-Early" release category. Over 99% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 80% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).
RCVCL-4	1.00E+00	0.2216	ACCIDENT CLASS IV	This is an accident class flag for Class IV events. Over 99% of the contribution is due to mechanical scram failure, but this is a data-based event and no viable enhancements to improve the reliability of this function have been identified. 100% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 80% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10). Over 23% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9).

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RPSYRPS-MECHFCC	2.10E-06	0.22004	SCRAM SYSTEM HARDWARE FAILURE	This event represents the probability that a mechanical scram failure occurs. This is a data-based event and no viable enhancements to improve the reliability of this function have been identified. The pre-core damage contributors are diverse, though over 23% include failure to bypass the MSIV low level interlock logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9). 100% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 80% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).
1OPPH-OP8-NOTFSU	8.20E-01	0.18303	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IV)	This event represents the probability that the RPV is depressurized in time to prevent RPV breach. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-IV-008	1.00E+00	0.18303	ACCIDENT SEQUENCE IV-008	This event is a Level 2 model accident sequence flag. In this scenario, a containment failure has occurred above the water line in the suppression pool, the RPV is depressurized, but injection is not available to prevent RPV breach. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).
%TT	6.58E-01	0.17773	TURBINE TRIP WITH BYPASS INITIATOR	Addressed in the Level 1 Importance Review.
1RHRXDHRRECLTH--	4.33E-01	0.16871	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	Addressed in the Level 1 Importance Review.
1RHSY-RHR-B--M--	6.54E-03	0.13909	RHR B TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that the RHR "B" division is out of service for maintenance when an initiating event occurs. The contributors to other RHR train failures are diverse, but venting failures (and subsequent containment failures that lead to loss of RPV makeup) are mostly due to the failure of the inboard containment vent valve to operate, support system unavailability, and operator failure to vent. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				valve that is qualified to operate in extreme environmental conditions (SAMA 8).
1CVOPVENTCTRLH--	5.00E-01	0.13657	VENT NOT CONTROLLED	This event represents the probability that the operators fail to control the containment venting process, which leads to loss of injection due to steam binding when NPSH is lost for the ECCS pumps taking suction from the suppression pool. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1SY--STEAMBOUND-	1.00E-02	0.13657	FAILURE TO CONTROL VENT CAUSES STEAM BINDING IN ECCS SUCTION	This event represents the probability of the low pressure ECCS pump failing after steam binding occurs when containment venting is not controlled and NPSH is lost. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).
RCVCL-2V	1.00E+00	0.13655	ACCIDENT CLASS IIV	This is an accident sequence flag event that identifies loss of containment heat removal scenarios in which venting is performed successfully followed by core damage on loss of RPV makeup. 100% of the class IIV scenarios include the failure to control venting with a subsequent failure of the ECCS pumps that take suction from the suppression pool due to steam binding. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				venting process could also improve the reliability of the vent control action (SAMA 4).
1CTPH-WW-IIV-FSU	1.00E+00	0.13655	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS IIV)	Containment break above the water line is an event that characterize a scrubbed release from the wetwell because the fission products have passed through the wetwell water volume. These scenarios are over 100% related to cases in which containment venting is the condition that leads to the release from the wetwell. In these cases, the venting process is not controlled and loss of NPSH leads to failure of the ECCS pumps for RPV makeup and core damage occurs. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				venting process could also improve the reliability of the vent control action (SAMA 4).
RCVL2-IIV-008	1.00E+00	0.13038	ACCIDENT SEQUENCE IIV-008	This event is an accident sequence flag that marks scenarios that include a loss of containment heat removal with subsequent successful containment venting. 100% of the cases include failure of ECCS pumps that take suction from the suppression pool due to steam binding of the pumps. While fire protection injection would be possible in many of these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-LOOP-006	1.00E+00	0.1235	ACCIDENT SEQUENCE LOOP-006	This event is an accident sequence flag. The LOOP-066 sequence in one in which RCIC and HPCS operate early, SPC fails, venting fails, and post-venting injection failure leads to core damage. Almost all contributors include either the failure of the operator to vent the containment or the failure of the inboard containment vent valve to operate in adverse conditions. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).
1CVOPSECT25-6H--	9.10E-03	0.12129	OP FAILS TO CNMT VENT PROC (4411.06 SECT 2.5, 2.6)	This event represents the failure of the operator to vent the primary containment using pathways that do not involve the cutting of pipes. It is primarily an execution error that is used in conjunction with a separate event that represent the failure to diagnose the need to perform containment venting. The HEP is relatively large due to the extensive number of steps involved in the venting process. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RHFN-1VY02C-X--	4.92E-03	0.09503	RHR A PUMP RM COOLER FAN FAILS TO RUN	This event represents a failure of the room cooler in the RHR A pump room, which contributes to loss of low pressure ECCS. Over 95% of the contributions include scenarios in which high pressure injection is initially successful, but injection is lost late due to containment failure or loss of NPSH when venting. While fire protection injection would be possible in many of these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Also, providing portable HVAC equipment could prevent pump failure (SAMA 13).
1RHFN-1VY03C-X--	4.92E-03	0.09491	RHR A HX ROOM FAN FAILS TO RUN	This event represents a failure of the room cooler in the RHR A Hx room, which contributes to loss of low pressure ECCS. Over 95% of the contributions include scenarios in which high pressure injection is initially successful, but injection is lost late due to containment failure or loss of NPSH when venting. While fire protection injection would be possible in many of these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Also, providing portable HVAC equipment could prevent pump failure (SAMA 13).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RHSY-RHR-A--M--	6.54E-03	0.09049	RHR A TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that the RHR "A" division is out of service for maintenance when an initiating event occurs. The contributors to other RHR train failures are diverse, but venting failures (and subsequent containment failures that lead to loss of RPV makeup) are mostly due to the failure of the inboard containment vent valve to operate due to adverse conditions (61%), and operator failure to vent (20%). A potential means of reducing the risk associates with the scenarios including this event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).
%TAC12E	2.93E-03	0.08662	LOSS OF 480 V BUS 1AP12E INITIATOR	This event represent the probability that a 480V AC bus fails during plant operation and leads to a plant trip. Over 98% of the contributors are general transient scenarios in which RCIC is lost due to Heat Capacity Temperature Limit (HCTL) violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 74% of the contributors are related to containment venting failure, with 69% being related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				Failure to control containment venting is about a 24% contributor, wich could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
1APSYLOOPIESWF--	2.40E-01	0.07661	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPAD-ALTRNT-F--	1.00E+00	0.07209	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). About 17% include SBO scenarios with load shed failures that lead to early loss of RCIC and depressurization capability. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Over 20% include failure of the SRVs to operate due to adverse environmental conditions in the Aux Building. Protecting the equipment or replacing it with equipment qualified to operate in adverse conditions could address these failures (SAMA 17). The remaining contributors include scenarios in which non-SBO power failures lead to loss of the ability to control the SRVs after battery depletion (multiple hours after plant trip), and these cases do not credit the existing Blackstart capabilities at CPS. The portable DC supplies can be used to operate the SRVs when the modeled power supplied are not available and these contributors would not be significant contributors if the Blackstart capabilities were credited. No additional SAMAs suggested.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-PRESBK-F--	8.00E-01	0.07209	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not cause by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	5.50E-01	0.07209	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	7.00E-01	0.07209	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
%TAC11E	2.93E-03	0.06971	LOSS OF 480 V BUS 1AP11E INITIATOR	This event represents the probability that a 480V AC bus fails during plant operation and leads to a plant trip. Over 94% of the contributors are general transient scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 85% of the contributors are related to containment venting failure, with 79% being related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). Failure to control containment venting is about a 9% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
%TC	6.72E-02	0.06781	LOSS OF CONDENSER VACUUM INITIATOR	This event represents the probability that a loss of condenser vacuum occurs during plant operation and leads to a plant trip. Over 75% of the contributors are general transient scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 72% of the contributors are related to containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				qualified to operate in extreme environmental conditions (SAMA 8). Failure to control containment venting is about a 5% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
%TF	6.96E-02	0.0653	LOSS OF FEEDWATER INITIATOR	This event represents the probability that a loss of feedwater occurs during plant operation and leads to a plant trip. About 78% of the contributors are general transient scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 76% of the contributors are related to containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). Failure to control containment venting is about a 5% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CTSYSTEAMBIND--	2.04E-01	0.06239	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	This event represents the probability of the low pressure ECCS pump failing after steam binding occurs when containment fails and NPSH is lost. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10).
1VYFN-DIV12PRXCC	1.50E-04	0.06112	CC DIV 1&2 PUMP ROOM COOLER FANS FAIL TO RUN	This event represents the common cause failure of the division 1 and division 2 room coolers to run for the mission time, which leads to loss or RHR pumps A, B. Providing procedures and portable equipment to provide alternate ECCS room cooling could reduce the risk from these scenarios (SAMA 13). Over 90% of the contributors are general transient or LOOP scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 72% of the contributors are related to containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). Failure to control containment venting is about a 5% contributor, which could be addressed by

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
1VYFN-DIV12HXXCC	1.50E-04	0.06091	CC DIV 1&2 HX ROOM COOLER FANS FAIL TO RUN	This event represents the common cause failure of the division 1 and division 2 RHR heat exchanger room cooler fans to run for the mission time, which leads to loss or RHR pumps A and B. Providing procedures and portable equipment to provide alternate ECCS room cooling could reduce the risk from these scenarios (SAMA 13). Over 90% of the contributors are general transient or LOOP scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 72% of the contributors are related to containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				qualified to operate in extreme environmental conditions (SAMA 8). Failure to control containment venting is about a 5% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
RCVSEQ-GTR-005	1.00E+00	0.0606	ACCIDENT SEQUENCE GTR-005	This is an accident sequence tag for the general transient tree in which HPCS operates in the long term without decay heat removal followed by successful containment venting. 100% of the contributors include loss of ECCS pumps due to failure to control venting to maintain NPSH. Failure to control containment venting is about a 5% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7).
RCVCL-1BE	1.00E+00	0.05956	ACCIDENT CLASS IBE	Addressed in the Level 1 Importance Review.
RCVSEQ-LOOP-099	1.00E+00	0.05922	ACCIDENT SEQUENCE LOOP-099	Addressed in the Level 1 Importance Review.
1DGRXDGREC30MH--	1.00E+00	0.05693	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
F-L2-CIV	1.00E+00	0.05682	FIRE FLAG FOR LEVEL 2 CONT ISOL VALVE FAILURE	This event is a flag that marks cases in which one or more containment isolation valves has failed to isolate. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are also over 99% LOOP-099 sequences. In the LOOP-099 sequences, RCIC, HPCS, and depressurization fail leading to subsequent core damage. Over 68% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 69% of the contribution includes successful depressurization after core damage, yet RX is assumed to be failed. If the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach could potentially be reduced (SAMA 10).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1VYFN-2VY06C-X--	4.92E-03	0.05627	RHR B PUMP RM COOLER FAN FAILS TO RUN	This event represents the common cause failure of the RHR "B" room cooler fan to run for the mission time, which leads to loss or RHR pumps A, B. Providing procedures and portable equipment to provide alternate ECCS room cooling could reduce the risk from these scenarios (SAMA 13). Over 90% of the contributors are general transient or LOOP scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 78% of the contributors are related to containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).
1VYFN-2VY05C-X--	4.92E-03	0.05616	RHR B HX ROOM COOLER FAN FAILS TO RUN	This event represents the common cause failure of the RHR "B" heat exchanger room cooler fan to run for the mission time, which leads to loss or RHR pumps A, B. Providing procedures and portable equipment to provide alternate ECCS room cooling could reduce the risk from these scenarios (SAMA 13). Over 90% of the contributors are general transient or LOOP scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. About 78% of the contributors are related to

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				containment venting failure related to failure of the inboard containment vent valve due to adverse conditions. These contributors could be mitigated by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).
1MSPH-BIIT---F--	1.00E+00	0.05498	SUPPRESSION POOL TEMP EXCEEDS BIIT	This is a flag event that indicates the crew has failed to bypass the low level MSIV isolation logic such that the MSIVs go closed and the main condenser is lost as a heat sink. Installing a keylock switch to simplify the process would improve the reliability of the logic bypass action (SAMA 9).
1MCTKINSUFF24HR-	1.25E-01	0.05371	INVENTORY IN THE MC TANK INSUFFICIENT FOR MISSION TIME	This event represents the probability that the Makeup Condensate tank will not have the volume required to support RPV injection using CND/FW for the PRA mission time. Over 84% of the contributors are general transient scenarios in which RCIC is lost due to HCTL violation, but HPCS successfully provides RPV makeup until either containment venting or containment failure leads to loss of the system. Failure to control containment venting is about a 64% contributor, which could be addressed by providing additional guidance and training on managing NPSH in adverse containment conditions (SAMA 7). A

Table F.5-2b
CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				potential means of reducing the risk associates with the scenarios including this event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).
1RHPM-1C002A-A--	2.88E-03	0.05267	PUMP A FAILS TO START	This event represents the failure of RHR pump "A" to start to support any of its functions. The contributors to other RHR train failures are diverse, but venting failures (and subsequent containment failures that lead to loss of RPV makeup) are mostly due to the failure of the inboard containment vent valve to operate due to adverse conditions (55%), and operator failure to vent (18%). A potential means of reducing the risk associates with the scenarios including this event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-ATW1-002	1.00E+00	0.05137	ACCIDENT SEQUENCE ATW1-002	This is the accident sequence ATW1-002 flag. In this sequence, Feedwater and the main condenser are available, but SLC/level control fails, leading to core damage. About 62% of the contribution is associated with common cause failure of the squib valves, which fails SLC injection. A means of reducing the risk associated with this failure would be to install a bypass line with MOV isolation valves (SAMA 16).
1MSRX-LLINTLKH--	1.00E+00	0.05106	RX: CREW FAILS TO BYPASS MSIV CLOSURE LOW LEVEL INTLK	This event represents the failure of the operator action to bypass the low level MSIV isolation logic in an ATWS. A potential plant enhancement to address this issue is to install a keylock switch to bypass the MSIV low level isolation logic (SAMA 9)

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
BSYPH-LERF---F--	1.00E+00	1	COND. PROB. OF A LERF (CLASS V)	This event is represents the conditional probability that the class V event are LERF, which is included in all cutsets in the HE/BOC release category and provides no specific insights. No SAMAs identified.
RCVCL-5	1.00E+00	1	ACCIDENT CLASS V	This event is an accident class flag for class v events, which is included in all cutsets in the HE/BOC release category and provides no specific insights. No SAMAs identified.
RCVL2-V-02	1.00E+00	1	ACCIDENT SEQUENCE V-02	This is the accident sequence marker for containment event tree sequence V-02, which is the only class V sequence and provides no specific insights. No SAMAs identified.
1--SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-BOC-002	1.00E+00	0.77674	ACCIDENT SEQUENCE BOC-002	This is an accident sequence tag for the break outside containment event tree which includes successful scram, success of HPCS, and a failure of long-term, low-pressure injection. Over 95% of the contributors include failure of the operator action to align service water for long-term, low-pressure injection. The HEP is driven by the short diagnosis and recovery time that has been assumed for the action, which includes a 20 minute system window (time within which the action must be complete) and an execution time of 16 minutes. The calculation notes that the system window is conservative for most scenarios and the alignment time currently accounts for local breaker manipulation associated with operation of the cross-tie valve between RHR and the Service Water (SW) system. The local breaker manipulation is not assumed to be performed in parallel with other tasks, which may increase the execution time estimate. The breaker is normally not installed to reduce the risk of inadvertent operation of the valve and no change is suggested for the breaker. A potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without impacting the conditions associated with the SW to RHR cross-tie valve (SAMA 18).

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
%BOC-MS	9.58E-08	0.76685	BOC INITIATOR IN MAIN STEAM SYSTEM	This is an initiating event representing the probability of a break outside containment in the main steam system. Over 95% of the contributors include failure of the operator action to align service water for long term, low pressure injection. The HEP is driven by the short diagnosis and recovery time that has been assumed for the action, which includes a 20 minute system window (time within which the action must be complete) and an execution time of 16 minutes. The calculation notes that the system window is conservative for most scenarios and the alignment time currently accounts for local breaker manipulation associated with operation of the cross-tie valve between RHR and the Service Water (SW) system. The local breaker manipulation is not assumed to be performed in parallel with other tasks, which may increase the execution time estimate. The breaker is normally not installed to reduce the risk of inadvertent operation of the valve and no change is suggested for the breaker. A potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without impacting the conditions associated with the SW to RHR cross-tie valve (SAMA 18).

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1SXOP-INIT-L-H--	3.12E-01	0.76264	OPERATOR FAILS TO ALIGN SX FOR LG OR MED STEAM LOCA (WITH EARLY INJECTION)	This event represents the probability that the operators will fail to align the Service Water (SW) system for long term RPV injection in time to prevent core damage. The HEP is driven by the short diagnosis and recovery time that has been assumed for the action, which includes a 20 minute system window (time within which the action must be complete) and an execution time of 16 minutes. The calculation notes that the system window is conservative for most scenarios and the alignment time currently accounts for local breaker manipulation associated with operation of the cross-tie valve between RHR and the SW system. The local breaker manipulation is not assumed to be performed in parallel with other tasks, which may increase the execution time estimate. The breaker is normally not installed to reduce the risk of inadvertent operation of the valve and no change is suggested for the breaker. A potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without impacting the conditions associated with the SW to RHR cross-tie valve (SAMA 18).

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-ISLOCA-002	1.00E+00	0.22181	ACCIDENT SEQUENCE ISLOCA-002	This event is an accident sequence flag for ISLOCA-002 events, which includes successful scram, success of HPCS, and a failure of long term low pressure injection. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-SDC	5.85E-09	0.14353	INTERFACING SYSTEM LOCA INITIATOR IN SDC SUCTION LINE	This is an initiating event representing the probability of an interfacing system LOCA in the shutdown cooling suction line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long-term, low-pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18). The CPS ISLOCA frequencies do not credit early isolation of valves in the break pathways due to inability of the valves to close against the high flow and pressure differential. Long term isolation is not credited as initial isolation actions are assumed to fail the valves due to thermal overload, though

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				recovery of this conditions is generally not complicated. A potential SAMA that could reduce uncertainty in the mitigation of ISLOCA scenarios would be replace valves in critical flow paths with one that is designed to close in ISLOCA condition (SAMA 11).
%ISLOCA-LPB	8.02E-10	0.01968	INTERFACING SYSTEM LOCA INITIATOR IN RHR LPCI INJ B	This is an initiating event representing the probability of an interfacing system LOCA in the LPCI "B" injection line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long-term, low-pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-LPC	8.02E-10	0.01968	INTERFACING SYSTEM LOCA INITIATOR IN RHR LPCI INJ C	This is an initiating event representing the probability of an interfacing system LOCA in the LPCI "C" injection line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long term, low pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-SDCB	8.02E-10	0.01968	INTERFACING SYSTEM LOCA INITIATOR IN SDC RETURN TRAIN B	This is an initiating event representing the probability of an interfacing system LOCA in the shutdown cooing "B" return line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long-term, low-pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
1RHSY-RHR-B--M--	6.54E-03	0.01599	RHR B TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that RHR train "B" is out of service for maintenance. In the contributing sequences, the ISLOCA or BOC initiator does not fail the RHR B injection path, but the maintenance event prevents it from being used for RPV makeup. HPCS is initially successful. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				Storage Tank without relying on the current RHR injection path (SAMA 18).
1RHXV-2F039B-P--	4.44E-03	0.01086	INJECTION LINE MANUAL VALVE F039B PLUGGED	Similar to the RHR maintenance event, the unavailability of the RHR "B" injection valve precludes long-term, low-pressure injection sources from injecting to the RPV. HPCS is initially successful in the scenarios in which this event is a contributor. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-LPA	8.02E-10	0.00641	INTERFACING SYSTEM LOCA INITIATOR IN RHR LPCI INJ A	This is an initiating event representing the probability of an interfacing system LOCA in the RHR LPCI "A" division injection line. The event is combined with a range of failures the prevent long-term low-pressure injection from reaching the RPV, but the largest contributor at over 95%, is the failure to align Service Water for long term injection (1SXOP-INIT-L-H--). This event is addressed above, and the same SAMAs would apply.
%ISLOCA-CS	8.02E-10	0.00641	INTERFACING SYSTEM LOCA INITIATOR IN LPCS SYSTEM	This is an initiating event representing the probability of an interfacing system LOCA in the LPCS system. The event is combined with a range of failures the prevent long-term low-pressure injection from reaching the RPV, but the largest contributor at over 95%, is the failure to align Service Water for long term injection

Table F.5-2c
CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				(1SXOP-INIT-L-H--). This event is addressed above and the same SAMAs would apply.
%ISLOCA-SDCA	8.02E-10	0.00641	INTERFACING SYSTEM LOCA INITIATOR IN SDC RETURN TRAIN A	This is an initiating event representing the probability of an interfacing system LOCA in the “A" division shutdown cooling return line. The event is combined with a range of failures the prevent long-term low-pressure injection from reaching the RPV, but the largest contributor at over 95%, is the failure to align Service Water for long term injection (1SXOP-INIT-L-H--). This event is addressed above and the same SAMAs would apply.
1RHMV-2F042B-D--	2.34E-03	0.00572	FAILURE OF RHR INJ MOV F042B TO OPEN	Similar to the RHR maintenance event, the unavailability of the RHR "B" injection valve precludes long-term, low-pressure injection sources from injecting to the RPV. HPCS is initially successful in the scenarios in which this event is a contributor. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1--SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RCVCL-H/L	1.00E+00	0.96818	ACCIDENT SEQUENCE H/L	This is a flag that identifies the "High-Late" release category. About 90% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 63% of the contribution is associated with sequences LOOP-053 and GTR-024 in which RCIC fails, but HPCS provides injection until containment failure leads to loss of injection, but catastrophic containment failure occurs in only 22% of the contributors. In the cases without catastrophic containment failure, the existing fire protection injection approach would likely be capable of providing makeup, but it is not credited. Providing a hard-piped connection that would simplify fire protection injection and reduce the time required to align the system would help further reduce these risks (SAMA 10)
1CVPH-SMALLD-F--	1.00E+00	0.89792	SMALL DIA VENTS ASSESSED AS	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
			UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	
RXF	1.00E+00	0.77438	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. Over 80% of the contributors include successful depressurization of the RPV before breach. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
B--OPDHR-EAL1F--	9.50E-01	0.76283	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the probability that operators successfully declare a general emergency in time to evacuate the population from the emergency protection zone before a significant release in loss of containment heat removal scenarios (Accident Class 2). Over 96% of the contribution includes the event that indicates that containment venting has failed and that the remaining vent paths were inadequate to provide adequate pressure relief/heat removal. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). In addition, over 69% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.
RCVCL-2A	1.00E+00	0.67423	ACCIDENT CLASS IIA	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RHRXDHRRECLTH--	1.00E+00	0.64429	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	Addressed in the Level 1 Fire Importance Review.
FLG-IE-LOOP	1.00E+00	0.63942	FLAG - FIRE IE LOOP	Addressed in the Level 1 Fire Importance Review.
1OPPH-OP6-NOTFSU	9.20E-01	0.62665	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	This event represents the probability that the RPV has been successfully depressurized prior to vessel breach in accident class 2 scenarios. In over 95% of these scenarios, the existing containment venting options have failed and the remaining small diameter vent paths are not able to provide sufficient pressure relief/decay heat removal. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). About 27% of the contributors are related to operator failures to align alternate injection to the RPV (either SW of fire protection), though the actions are assumed to always fail. Providing a hard-piped connection that would simplify fire protection injection and reduce the time required to align the system would help reduce these risks (SAMA 10). In addition, about 71% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.
1APRXOSP20HPCH--	1.00E+00	0.59052	FAILURE TO RECOVER OSP WITHIN 20 HOURS (PLANT CENTERED LOOP EVENT)	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-LOOP-053	1.00E+00	0.54993	ACCIDENT SEQUENCE LOOP-053	Addressed in the Level 1 Fire Importance Review.
1CTPH-WW-NOT-F--	8.00E-01	0.44111	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	The event represents the fraction of containment failures that occur above the water line in the suppression pool (leads to a scrubbed release). Over 99% of the contribution includes the event that indicates that containment venting has failed and that the remaining vent paths were inadequate to provide adequate pressure relief/heat removal. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). In addition, about 80% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.
1CTSY-WWLOSS-R--	2.00E-01	0.42245	WW RUPTURE CAUSES LOSS OF WATER IN POOL	Addressed in the Level 1 Fire Importance Review.
RCVL2-II-009	1.00E+00	0.32549	ACCIDENT SEQUENCE II-009	This event is an accident sequence flag. Over 82% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be reduced; however, catastrophic containment failure occurs in about 46% of the contributors. Providing FLEX-like hardened containment vent (SAMA 4) would reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
1DGRXDGREC30MH--	1.00E+00	0.32209	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Fire Importance Review.
RCVL2-II-030	1.00E+00	0.27904	ACCIDENT SEQUENCE II-030	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is below the waterline (non-scrubbed release), a depressurized RPV, and a failure to prevent RPV breach. Over 88% of the risk comes from Level 1 scenarios in which high pressure RPV makeup is successful, but containment heat removal systems and containment venting fail, followed by failure of injection after containment failure. Venting failure is generally due to lack of support system availability. These contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4), and some

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
1CTSYSTEAMBIND--	2.04E-01	0.21431	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	Addressed in the Level 1 Fire Importance Review.
1CTSYLRGPCFLLR--	2.00E-01	0.21385	CONT. CATASTROPHIC FAILURE MODE	Addressed in the Level 1 Fire Importance Review.
1OPAD-ALTRNT-F--	1.00E+00	0.15792	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). Over 80% are related to sequence LOOP-053. In these cases, the RCIC fails, but HPCS operates successfully until containment failure leads to loss of RPV injection. Catastrophic containment failure occurs in about 25% of the contributors, but for the remaining contributors, if the fire protection system was hard piped to allow early injection to the RPV (SAMA 10), there would be adequate time to align the FLEX generator for long term DC support, SRV operation, and RPV makeup could be maintained. With regard to containment venting failures, these contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4), and some portion of the

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
1OPPH-PRESBK-F--	8.00E-01	0.15792	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a mechanical system hardware failure does not occur that will lead to depressurization of the RPV after core damage, hence, the event is present in scenarios that remain at high pressure after core damage until vessel breach. It is noted that RPV depressurization failure is include in LOOP-053 in which RCIC fails, but HPCS succeeds, which is about an 80% contributor; however, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails. Use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4) would reduce the risk for these scenarios, and some portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-SORV---F--	5.50E-01	0.15792	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that the SRVs do not stick open and lead to depressurization of the RPV after core damage, hence, the event is present in scenarios that remain at high pressure after core damage until vessel breach. It is noted that RPV depressurization failure is include in LOOP-053 in which RCIC fails, but HPCS succeeds, which is about a 80% contributor; however, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails. Use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4) would reduce the risk for these scenarios, and some portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-TEMPBK-F--	7.00E-01	0.15792	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that high primary system temperatures do not lead to failures that would lead to depressurization of the RPV after core damage, hence, the event is present in scenarios that remain at high pressure after core damage until vessel breach. It is noted that RPV depressurization failure is include in LOOP-053 in which RCIC fails, but HPCS succeeds, which is about a 80% contributor; however, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails. Use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4) would reduce the risk for these scenarios, and some portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
1DGDG-DG01KB-X--	3.07E-02	0.14901	FAILURE OF DIESEL GENERATOR 01KB TO RUN	Addressed in the Level 1 Fire Importance Review.
1DGDG-DG01KA-X--	3.07E-02	0.1488	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1SMSY-SUCC---F--	9.90E-01	0.13375	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Fire Importance Review.
1RHRX-REC-UPDH--	1.00E+00	0.12572	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	Addressed in the Level 1 Fire Importance Review.
FIRE-TT	1.00E+00	0.12457	FIRE INDUCED TURBINE TRIP	Addressed in the Level 1 Fire Importance Review.
FLG-IE-TT	1.00E+00	0.12457	FLAG - FIRE IE TT	Addressed in the Level 1 Fire Importance Review.

1CVMV-FAILOP-F--	1.00E+00	0.11568	MOTOR OPERATED VALVE FC007 CLOSES	This event is used to represents the probability that a valve in one of the containment vent paths is closed at the time venting is required. It would normally be isolated early in the accident scenario and no credit is taken for the valve being left open in the even that motive power to the valve is lost (i.e., if motive power is lost, the valve is closed and cannot be opened for the containment venting function). Over 86% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment

Table F.5-2d
CPS Fire Level 2 High-Early/High-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
1SXOP-RXSWINJH-F	1.00E+00	0.1051	OPERATOR FAILS TO INITIATE SX INJECTION THROUGH RHR DISCHARGE LINE B - FIRE PRA	Addressed in the Level 1 Fire Importance Review.
RCVCL-1A	1.00E+00	0.10445	ACCIDENT CLASS IA	Addressed in the Level 1 Fire Importance Review.
1FPOPALIGN-FPH-F	1.00E+00	0.09754	OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION	Addressed in the Level 1 Fire Importance Review.
1OPPH-OP1-NOTFSU	8.80E-01	0.0974	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IA, IE)	This event represents the probability that the RPV is successfully depressurized before RPV breach in the Level 2 model for accident class IBL sequences. Over 49% of the contributors are from the IA1-040 sequence in the Level 2 model in which depressurization before RPV breach is successful, RPV breach does occur, no energetic containment failure occurs, containment and drywell isolation are successful, RPV injection before containment failure fails, pool scrubbing is available for the release, containment venting fails, and the containment fails below the water line. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage as well as reducing the

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				probability that injection is failed to be aligned before RPV breach and drywell shell failure after core damage (SAMA 10). Failure to control RCIC from the remote shutdown panel in MCR abandonment scenarios is about a 20% contributor. Review of the action indicates the HEP is mostly related to execution error, and it is a result of the relatively large number of steps related to operating the system at the RSP and the short amount of time available in the limiting scenario when no injection is available. No changes to the control scheme have been identified that would significantly reduce the HEP; however, the enhancement to the fire protection system would also help prevent RPV breach/DW failure in the same scenarios. A FLEX-like vent capability (SAMA 4) would also reduce the probability containment vent failure.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1HRSY-RHRCN--F--	1.00E+00	0.09185	CONTINGENCY METHODS INADEQUATE (NOT CREDITED)	This event represents the unavailability of other containment heat removal methods due to lack of procedures or capacity. Over 96% of the contributors are related to fire induced failure of suppression pool temperature indicators that are assumed to be required for suppression pool cooling initiation. This is conservative because operators would have alternate indication that the suppression pool temperature would be over the initiation temperature of 95 degrees F, including the cycling of SRVs. In over 96% of the contributors, the RPV is depressurized before RPV breach. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage as well as reducing the probability that injection is failed to be aligned before RPV breach and drywell shell failure after core damage (SAMA 10).
1MCHU-PCSUNAVH--	1.00E+00	0.09185	PCS UNAVAILABLE AS HEAT SINK	This event is a flag event representing the unavailability of the main condenser as a heat sink. It is combined under an AND gate with event 1HRSY-RHRCN--F-- (addressed above) and all of the same SAMAs for that event are applicable to 1MCHU-PCSUNAVH--.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
F-HFE-051-INSTR	1.00E+00	0.08839	INSTRUMENT FAILURE PREVENTS OPERATOR ACTION 1RHOP-L2-TC--H--	This event represents the failure of the instruments used to support suppression pool cooling initiation. The instruments linked to the event are suppression pool temperature indications and while these are the primary indications that would be used to cue initiation of the system, there are alternate indications that would be available to the operators that are not credited in the PRA, including cycling of the SRVs. In over 99% of the contributors, the RPV is depressurized before RPV breach. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage as well as reducing the probability that injection is failed to be aligned before RPV breach and drywell shell failure after core damage (SAMA 10).
RCVSEQ-GTR-024	1.00E+00	0.08367	ACCIDENT SEQUENCE GTR-024	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVL2-II-023	1.00E+00	0.07814	ACCIDENT SEQUENCE II-023	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is above the waterline, the RPV at high pressure at the time of breach, no energetic drywell or containment failure, and a failure occurs that leads to bypass of the suppression pool (non-scrubbed release). Over 97% of the risk comes from Level 1 scenarios in which high pressure RPV makeup is successful, but containment heat removal systems and containment venting fail, followed by failure of injection after containment failure. Venting failure is generally due to lack of support system availability. These contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4), and some portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
FLG-IE-MCR	1.00E+00	0.06966	FLAG - FIRE IE MCR ABANDONMENT	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
FLG-IE-S1	1.00E+00	0.06656	FLAG - FIRE IE MLOCA	This event is a flag event that marks fire induced Medium LOCA in the model. In 67% of the contributors, the HPCS system injects successfully, suppression pool cooling fails, containment venting fails, injection fails after containment failure, and core damage occurs. In those cases for which failure of containment venting leads to loss of the operating injection system, vent failure is generally due to loss of support systems. In some cases, power for vent support would be available with current FLEX capabilities that are not credited in the model, but providing a FLEX-like hard piped vent path that can be operated without support systems would reduce plant risk (SAMA 4).
1RXRX-FRECINJH--	1.00E+00	0.06556	OPERATOR FAILS TO RECOVER INJECTION BEFORE RPV MELT	This event represents the probability that previously failed injection systems will be restored to operation in time to prevent vessel melt-through. No credit is taken for these types of recovery actions here (1.0 failure probability). Over 67% of the scenarios are high pressure core melts that include successful depressurization after core damage and another 33% are medium water LOCA events that would depressurize due to the LOCA. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage (for the non-MLOCA events) as well as reducing the probability that injection is failed to be aligned before

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				RPV breach and drywell shell failure after core damage (SAMA 10).
1SYOPCB201221H-F	3.74E-02	0.05611	OPERATOR FAILS TO OPEN RAT/ERAT CB 201 OR CB 221	Addressed in the Level 1 Fire Importance Review.
RCVCL-1BL	1.00E+00	0.05611	ACCIDENT CLASS IBL	Addressed in the Level 1 Fire Importance Review.
1APRXOSP6HRPCH--	1.00E+00	0.05588	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED LOOP EVENT)	Addressed in the Level 1 Fire Importance Review.
1APRXL26HRPC-H--	1.00E+00	0.05469	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored in time to prevent RPV breach after core damage. About 73% are LOOP-092 sequences in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. About 26% of the contributors are LOOP-078 sequences that also include successful initial RCIC operation, but depressurization is successful followed by failure of the low-pressure injection systems. In the cases, the existing capabilities would support SRV operation such that enhancing the fire protection injection capability by installing a hard pipe connection would help prevent core damage as well as reducing the releases by preventing RPV breach (SAMA 10).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RPRXYDCLOAD-H-F	1.00E+00	0.05421	RX: DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL (FIRE VERSION)	Addressed in the Level 1 Fire Importance Review.
1SYRXCB201221H-F	1.00E+00	0.05343	RX: OP FAILS TO OPEN RAT/ERAT CB 201 OR CB 221 (FIRE VERSION)	Addressed in the Level 1 Fire Importance Review.
RCVL2-II-031	1.00E+00	0.05108	ACCIDENT SEQUENCE II-031	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is below the waterline, failure to depressurize the RPV, and RPV breach at high pressure. About 93% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10). These contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4), and some portion of the contributors could be addressed by providing procedure

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).
%F_A-2K_1AP06E_H_O	2.78E-05	0.05079	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI - Initiator	This event represents the probability that a high energy arcing fault occurs in a 4KV switchgear. About 95% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach. These contributors can also be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4), and some portion of the contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1--SYAVAILFAC---	9.53E-01	1	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RXF	1.00E+00	0.7093	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. Over 67% of the contributors include successful depressurization of the RPV before breach. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-M/L	1.00E+00	0.53349	ACCIDENT SEQUENCE M/L	This is the accident flag event for the medium-low release category. Sequence LOOP-092 is a 44% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 53% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach. About 22% of the contributors include failure of the containment venting function. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).
FLG-IE-LOOP	1.00E+00	0.49337	FLAG - FIRE IE LOOP	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-M/E	1.00E+00	0.48084	ACCIDENT SEQUENCE M/E	This is a flag that identifies the "Medium-Early" release category. Over 99% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 67% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).
RCVCL-1BE	1.00E+00	0.47282	ACCIDENT CLASS IBE	Addressed in the Level 1 Fire Importance Review.
1APRXOSP2HRPCH--	1.00E+00	0.47277	FAILURE TO RECOVER OSP WITHIN 2 HOURS (PLANT CENTERED LOOP EVENT)	Addressed in the Level 1 Fire Importance Review.
F-L2-CIV	1.00E+00	0.47275	FIRE FLAG FOR LEVEL 2 CONT ISOL VALVE FAILURE	This event is a flag that marks cases in which one or more containment isolation valves has failed to isolate. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are also over 99% LOOP-099 sequences. In the LOOP-099 sequences, RCIC, HPCS, and depressurization fail leading to subsequent core damage. Over 64% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 68% of the contribution includes successful depressurization after core damage, yet RX is assumed to be failed. If the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach could potentially be reduced (SAMA 10).
1APRXL218HRPCH--	1.00E+00	0.47275	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 18 HR IN NODE SI	This event represents the conditional probability that AC power is not restored in time to prevent drywell failure after core damage. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are also over 99% LOOP-099 sequences. In the LOOP-099 sequences, RCIC, HPCS, and depressurization fail leading to subsequent core damage. Over 64% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 68% of the contribution includes successful depressurization after core damage, yet RX is assumed to be failed. If the FPS connection

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach could potentially be reduced (SAMA 10).
RCVSEQ-LOOP-099	1.00E+00	0.4714	ACCIDENT SEQUENCE LOOP-099	Addressed in the Level 1 Fire Importance Review.
1OPPH-OP7-NOTFSU	6.90E-01	0.32146	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBE)	This event represents the probability that RPV depressurization occurs before vessel breach. Over 95% of the contribution containing this event is associated with the LOOP-099 sequence and they are all "early" SBO scenarios. Over 62% of the contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). Over 37% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar contributors for different time intervals. A

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).
RCVL2-IBE1-063	1.00E+00	0.32139	ACCIDENT SEQUENCE IBE1-063	This is the accident sequence IBE-063 flag. In this sequence, the RPV is depressurized before RPV breach, but injection fails to prevent RPV breach. There is no energetic containment failure, but there are both containment and drywell isolation failures as well as failure of containment spray and containment failure due to lack of injection. Over 99% of the contribution containing this event is associated with the LOOP-099 sequence and they are all "early" SBO scenarios. Over 62% of the contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). Over 37% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				contributors for different time intervals. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).
1CTPH-WW-NOT-F--	8.00E-01	0.29435	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	This event represents the probability that the location of the containment breach will be above the water line (leads to a scrubbed release). Generally, the pre-core damage contributors are diverse and overpressure is the result of both level/power control failures as well as failure of containment heat removal. Over 98% of the contributors are cases in which the RPV is depressurized, but RPV breach is not prevented. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach could potentially be reduced (SAMA 10). However, about 17% of the cases include catastrophic containment failure and, in these scenarios, the injection lines may be lost. About

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				43% of the contributors include containment venting failures which, if eliminated, would lead to a significant reduction in the release magnitude. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).
1DGRXDGREC30MH--	1.00E+00	0.25956	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Fire Importance Review.
1OPAD-ALTRNT-F--	1.00E+00	0.2489	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). Over 65% are related to sequence LOOP-099. In these cases, the model does no credit depressurization and use of fire protection injection in the scenarios in which RCIC is failed; however, if the fire protection system was hard piped to allow early injection to the RPV (SAMA 10), there would be adequate time to align the FLEX generator for long term DC support, SRV operation, and RPV makeup. In a separate 31% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2)

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-PRESBK-F--	8.00E-01	0.2489	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not cause by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	5.50E-01	0.2489	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	7.00E-01	0.2489	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVCL-1BL	1.00E+00	0.24585	ACCIDENT CLASS IBL	This is the Accident Class IBL flag (station blackout, late). Approximately 77% of the Class 1BL contributors include a failure to locally open RAT/ERAT circuit breakers given they failed to automatically open (see 1SYOPCB201221H-F for details). Additionally, random failure of the EDGs (including common cause failures) are significant contributors. Since common cause failure is a major contributor to EDG unavailability, an additional EDG is not suggested as a SAMA to address the risk because the new EDG would be added to the same common cause group as the existing EDGs. Sequence LOOP-092 is a 95% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 68% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXL26HRPC-H--	1.00E+00	0.24585	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored in time to prevent RPV breach after core damage (not credited in Fire). Sequence LOOP-092 is a 95% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 68% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXOSP6HRPCH--	1.00E+00	0.24585	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED LOOP EVENT)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). Sequence LOOP-092 is a 95% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 68% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1APRXL220HRPCH--	1.00E+00	0.2457	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 20 HRS. NODE SI	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). Sequence LOOP-092 is a 95% contributor to these scenarios and those sequences include failure to depressurize the RPV. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 68% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach.
1SYRXCB201221H-F	1.00E+00	0.24437	RX: OP FAILS TO OPEN RAT/ERAT CB 201 OR CB 221 (FIRE VERSION)	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
RCVSEQ-LOOP-092	1.00E+00	0.23357	ACCIDENT SEQUENCE LOOP-092	This is the accident sequence LOOP-092 flag. The sequence includes initial success of RCIC with failure of required support to provide long term injection, failure of HPCS, failure of RPV depressurization, and failure to recover offsite power in time to prevent core damage. However, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long-term scenarios. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). SAMA 10 would also address 68% of the contributors that include successful depressurization after core damage by allowing injection to prevent RPV breach.
1RPRXYDCLOAD-H-F	1.00E+00	0.22337	RX: DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL (FIRE VERSION)	Addressed in the Level 1 Fire Importance Review.
F-CB-D1-HS	6.00E-01	0.20989	CIRCUIT BREAKER (DIV 1) HOT SHORT PROBABILITY	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
F-CB-D2-HS	6.00E-01	0.20989	CIRCUIT BREAKER (DIV 2) HOT SHORT PROBABILITY	Addressed in the Level 1 Fire Importance Review.
FDEPGROUP-COMB013	3.91E-02	0.19409	FIRE HEP DEPENDENCY GROUP 013	Addressed in the Level 1 Fire Importance Review.
1APOP-OSP30M-H--	1.00E+00	0.16953	OPERATOR FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RX OF OSP WITHIN 30 MINS	Addressed in the Level 1 Fire Importance Review.
1OPPH-OP5-NOTFSU	6.90E-01	0.16877	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBL)	This event represents the probability that the RPV is successfully depressurized before RPV breach in the Level 2 model for accident class IBL sequences. Over 93% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage as well as reducing the probability that injection is failed to be aligned before RPV breach and drywell shell failure after core damage (SAMA 10).
1SYOPCB201221H-F	3.74E-02	0.16713	OPERATOR FAILS TO OPEN RAT/ERAT CB 201 OR CB 221	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
FLG-IE-MCR	1.00E+00	0.16686	FLAG - FIRE IE MCR ABANDONMENT	This is a flag that indicates main control room (MCR) abandonment due to fire-induced loss of habitability or loss of control. The SAMAs discussed to address the risk from event RCVCL-1A are applicable to this event.
RCVL2-IBL-063	1.00E+00	0.15794	ACCIDENT SEQUENCE IBL-063	This is the accident sequence IBL-063 flag. In this sequence, the RPV is depressurized before RPV breach, but injection fails to prevent RPV breach. There is no energetic containment failure, but there are both containment and drywell isolation failures, as well as failure of containment spray and containment failure due to lack of injection. Over 99% of the contribution containing this event is associated with the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk of core damage would be greatly reduced for these scenarios. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of core damage as well as reducing the probability that injection is failed to be aligned before RPV breach and drywell shell failure after core damage (SAMA 10).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1OPPH-OP6-NOTFSU	9.20E-01	0.15527	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	The event represents the probability of successfully depressurizing the RPV before RPV breach in accident class II sequences. RPV breach is currently assumed to always occur; however, injection with fire protection could potentially prevent some failures in it current configuration. Further risk reductions could be realized by providing a hard piped connection for fire protection injection (SAMA 10). However, because catastrophic containment failure occurs in about 30% of the contributors, preventing containment failure is more likely to reduce plant risk. Failure of containment venting is an 72% contributor (primarily due to loss of support systems). Installing a hard pipe FLEX vent (SAMA 4) is an option to mitigate these scenarios.
B--OPDHR-EAL1F--	9.50E-01	0.15379	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the probability that operators successfully declare a general emergency in time to evacuate the population from the emergency protection zone before a significant release in loss of containment heat removal scenarios (Accident Class 2). Over 72% of the contribution includes the event that indicates that containment venting has failed and that the remaining vent paths were inadequate to provide adequate pressure relief/heat removal. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). RPV breach occurs in all cases, but

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				the RPV is depressurized before breach in over 97% of the contributors. Enhancing the fire protection injection capability by installing a hard pipe connection would reduce the risk of RPV breach (SAMA 10).
%F_T-1H_1TO02S_O_W	1.37E-04	0.14076	Fire at Seal Oil Unit 1TO02S (Severe) - Undeveloped - Initiator	Addressed in the Level 1 Fire Importance Review.
RCVL2-II-008	1.00E+00	0.13772	ACCIDENT SEQUENCE II-008	This event is a Level 2 model accident sequence tag. The sequence includes a depressurized RPV before vessel breach, but failure to prevent vessel breach with containment failure in the wetwell airspace (scrubbed release). The 1.0 probability for the prevention of vessel breach is due to the fact that injection after containment failure has failed to prevent core damage, which includes the potential for depressurization to fail; hence, if depressurization failure did not occur, then all injection has failed for other reasons. 78% of the contributors include containment vent failure and about 32% of the scenarios include catastrophic containment failures that fail the RPV injection paths (SAMAs 4 and 8 address). The around 25% of the contributors include failure of pumps taking suction from the suppression pool due to steam binding after rapid containment depressurization. Because the fire protection system is currently not credited in these long-term scenarios when alignment would likely be possible, the risk from loss of injection due to steam binding is likely over estimated and no additional SAMAs are

Table F.5-2e
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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				required, though SAMA 10 could further reduce risk.
1OPPH-OP1-NOTFSU	8.80E-01	0.13705	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IA, IE)	This event represents the probability that the RPV is successfully depressurized before RPV breach in the Level 2 model for accident class IBL sequences. Over 99% of the contributors are from the IA1-039 sequence in the Level 2 model in which depressurization before RPV breach is successful, RPV breach does occur, no energetic drywell or containment failure occur, no DW isolation failure occurs, containment failure due to lack of injection does occur, drywell pool and suppression pool scrubbing are intact/successful, and containment venting fails. The CPS model does not credit the fire protection system for RPV injection and in some cases, the current configuration could potentially prevent vessel failure. Enhancing the fire protection injection capability by installing a

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				hard pipe connection would further reduce the risk of RPV breach (SAMA 10).
RCVCL-1A	1.00E+00	0.13705	ACCIDENT CLASS IA	Addressed in the Level 1 Fire Importance Review.
RCVL2-IA1-039	1.00E+00	0.13594	ACCIDENT SEQUENCE IA1-039	This is a flag event for level 2 containment event tree sequence IA1-039. The IA1-039 sequence in the Level 2 model in which depressurization before RPV breach is successful, RPV breach does occur, no energetic drywell or containment failure occur, no DW isolation failure occurs, containment failure due to lack of injection does occur, drywell pool and suppression pool scrubbing are intact/successful, and containment venting fails. The CPS model does not credit the fire protection system for RPV injection and in some cases, the current configuration could potentially prevent vessel failure. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of RPV breach (SAMA 10).

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1SMSY-SUCC---F--	9.90E-01	0.13373	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Fire Importance Review.
1CVPH-SMALLD-F--	1.00E+00	0.12617	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Fire Importance Review.
1RHRX-REC-UPDH--	1.00E+00	0.12308	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	This event represents the failure to recover the RHR system for heat removal given that the upper pool inventory was successfully transferred to the lower pool (provides more time to reach adverse containment conditions). 63% are Class IIA scenarios, which are addressed by the SAMAs discussed for the RCVCL-2A event. Failure of containment vent is a 67% contributor. Providing a pathway that is straightforward to use, is operable under adverse conditions without support systems, and having directions the clearly direct selection of the vent path would improve reliability (SAMA 4). The RPV is depressurized before vessel breach in 97% of the contributors. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of RPV breach (SAMA 10). 9% are Class IIV scenarios. A dominant contributor to the Class IIV scenarios is the failure to control the containment vent process to maintain NPSH for the pumps taking suction from the suppression pool. Currently, the CPS procedures do not provide specific guidance for controlling venting to preserve injection pump operation and

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				operator training does not extend to long term scenarios to provide detailed practice on this action. A potential enhancement would be to include guidance in the EOPs related to controlling vent pressure to maintain NPSH and to include this action in the training program (SAMA 7).
1DGDG-DG01KB-X--	3.07E-02	0.1205	FAILURE OF DIESEL GENERATOR 01KB TO RUN	Addressed in the Level 1 Fire Importance Review.
RCVL2-IBE2-054	1.00E+00	0.11148	ACCIDENT SEQUENCE IBE2-054	This is a flag event for level 2 containment event tree sequence IBE2-054. The IBE2-054 sequence in the Level 2 model in which depressurization before RPV breach is failed and RPV breach does occur, energetic drywell failure occurs but there is no energetic failure of containment, containment failure due to lack of injection does occur, and containment spray fails. After RPV breach, FPS injection would be available, but it is not credited in the existing configuration. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of containment failure (SAMA 10).
FIRE-TT	1.00E+00	0.10749	FIRE INDUCED TURBINE TRIP	Addressed in the Level 1 Fire Importance Review.
FLG-IE-TT	1.00E+00	0.10749	FLAG - FIRE IE TT	Addressed in the Level 1 Fire Importance Review.

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EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1CZPH-HPBDVS2F--	5.00E-01	0.09797	RPV BLOWDOWN OVERWHELMS VS AND FAILS DW (OP=F)	This event represents the probability that when the RPV fails at high pressure after core damage, the blowdown exceeds the vapor suppression capacity and fails the drywell. Over 41% of the contribution is related to failure of DC load shed. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). In addition, CPS Blackstart capabilities, which can support SRV operation, are not credited in the model. In about 25% of the scenarios, power is restored to the switchyard, but it cannot be aligned to the emergency buses in time to prevent core damage. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).
RCVSEQ-MCR-004	1.00E+00	0.09724	ACCIDENT SEQUENCE MCR-004	This is the accident sequence MCR-004 flag. This is Accident Class 1A (loss of inventory makeup while at high pressure) and the SAMAs discussed to address the risk from event RCVCL-1A are applicable to this event.
RCVCL-2A	1.00E+00	0.08591	ACCIDENT CLASS IIA	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RPOPYDCLOAD-H-F	4.57E-01	0.08187	DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL - FIRE PRA VERSION	This event represents the failure of the operators to perform the DC load shedding task during ELAP scenarios to ensure the DC battery life is adequate to support implementation of FLEX strategies. While the HEP is not large, there are estimated to be 20 minutes available for recover actions after performance in the event an error is made. The difficulty is finding the error with limited personnel. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed. This could support a checking process improve the reliability of the action (SAMA 2).
1CZPH-CZ4-NOTFSU	4.10E-01	0.07949	HIGH PRESSURE BLOWDOWN DOES NOT OVERWHELM VAPOR SUPPRESSION	The event is used in the event tree sequences to quantitatively adjust the probability of the sequences in which the CZ (energetic containment failure) does not occur. Because the CZ failure probability is large, the assumption that the success path probability can be approximated as 1.0 is not justified and this event is used to address the issue. About 66% of the scenarios are IBE2-035 sequences in which containment fails after RPV breach at high pressure. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of containment failure (SAMA 10). About 33% of the risk is associated with the longer term IBL2-035 sequence in which the same sequence of events occurs such that SAMA 10 is also applicable.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1DGDG-DG01KA-X--	3.07E-02	0.07865	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-GTR-024	1.00E+00	0.0635	ACCIDENT SEQUENCE GTR-024	Addressed in the Level 1 Fire Importance Review.
F-CB201A1-FTO-HS	6.00E-01	0.06162	HOT SHORT PROBABILITY FOR CB 201A1	This is a conditional hot short probability event given fire-induced cable damage that prevents the RAT/ERAT circuit breakers from opening. This event is related to action 1SYOPCB201221H-F, so the SAMAs identified for that operator action would apply to this hot short probability (i.e., action 1SYOPCB201221H-F is taken in response to fire-induced cable damage). Additionally, installing 3-hour rated fire cable wrap on the cables that could prevent the circuit breakers from opening throughout their entire cable routing would reduce fire CDF risk by approximately 10% (SAMA 14).
RCVCL-2T	1.00E+00	0.06132	ACCIDENT CLASS IIT	This is the Accident Class 2T (loss of containment heat removal with the RPV initially intact; core damage induced post containment high containment pressure). A large contributor (about 49%) is the inability of the small diameter vent paths to provide venting capabilities. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). For the remaining contributors, ECCS room cooling failures are primarily responsible for loss of suppression pool cooling. Providing procedures and portable equipment to provide alternate

Table F.5-2e
CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				ECCS room cooling could reduce the risk from these scenarios (SAMA 13).
RCVL2-IBL2-054	1.00E+00	0.05641	ACCIDENT SEQUENCE IBL2-054	This is a flag event for level 2 containment event tree sequence IBL2-054. The IBL2-054 sequence in the Level 2 model in which depressurization before RPV breach is failed and RPV breach does occur, energetic drywell failure occurs but there is no energetic failure of containment, containment failure due to lack of injection does occur, and containment spray fails. After RPV breach, FPS injection would be available, but it is not credited in the existing configuration. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of containment failure (SAMA 10).
1FPOPALIGN-FPH-F	1.00E+00	0.05486	OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION	A number of alternate injection sources are available given loss of primary injection systems (i.e., feedwater, RCIC, HPCS, LPCS, LPCI). One alternate system is fire water injection via RHR B. This action requires operators to align fire water to RHR B following removal of the internals of one check valve in order to permit required flow. Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
1RIOP-RSDP---H-F	3.91E-02	0.05285	OPERATOR FAILS TO CONTROL RCIC FROM THE RSDP (FIRE VERSION)	This event represents the failure of the operators to control the plant from the remote shutdown panel after MCR abandonment. 100% are associated with level 2 sequence IA1-039 in which depressurization before RPV breach is successful, RPV breach does occur, no energetic drywell or containment failure occur, no DW isolation failure occurs, containment failure due to lack of injection does occur, drywell pool and suppression pool scrubbing are intact/successful, and containment venting fails. The CPS model does not credit the fire protection system for RPV injection and in some cases, the current configuration could potentially prevent vessel failure. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of RPV breach (SAMA 10).
F-CO2	1.00E+00	0.05285	CO2 PANEL FAILURE	This event is a flag event that marks the unavailability of the CO2 panel in a fire event. The fires are MCR fires that fail the panel that controls all of the EDGs. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). In addition, over 99% include successful RPV depressurization before RPV breach. Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

EVENT NAME	PROBABILITY	FUS VES	DESCRIPTION	POTENTIAL SAMAS
				would allow for credit of this alternate injection method (SAMA 10).
RCVL2-IBE2-035	1.00E+00	0.05276	ACCIDENT SEQUENCE IBE2-035	This is the flag event for level 2 containment event sequence IBE2-035, which includes containment failure after RPV breach at high pressure. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of containment failure (SAMA 10).

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
1	Provide Portable HVAC Equipment and Supporting Procedures for Alternate DG Room Cooling	For scenarios involving loss of room cooling for the EDGs, providing a diverse, portable fan/ductwork to indefinitely maintain room temperature in the acceptable range would prevent SBO/loss of 4KV power due to HVAC failures.	FPIE Importance Lists	$399,746 (DEK 2008) Includes room heatup analysis, design changes, addition of high room temp alarms, portable fans, and a procedure change.	Implementation cost is less than MACR. Retain for Phase II analysis
2	Proceduralize DC Current Check for ELAP Load Shed Action	Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.	FPIE Importance Lists	$50, 000 (Entergy 2017) Estimate for a minor change to a non-EOP procedure with limited training requirements.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
3	Protect the RCIC Storage Tank, Provide Long Term Makeup, and Support Containment Venting for Heat Removal	While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control (procedure changes to use FLEX generator assumed to be required in some cases) would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.	FPIE Importance Lists	\$8,915,554 (S&L 2023) CPS-specific cost estimate for installing a pre-cast concrete enclosure similar to the FLEX storage building, with thicker panels, attached to the Fuel Building west wall, and mounted on new footings.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
4	Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.	FPIE Importance Lists Fire Importance Lists	$12.94 million (Exelon 2014) This LaSalle estimate does not include contingency costs.	Implementation cost is less than MACR. Retain for Phase II analysis
5	Install an Emergency Tie Line From the Switchyard to an Emergency Bus	The process to restore offsite AC power to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.	FPIE Importance Lists	$400,000 (WCN 2006) Wolf Creek estimated the cost of providing the MCR with the capability of remotely aligning a local generating station to the site. This is considered to be similar in scope to the CPS SAMA and it has been used as an approximation of the cost.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
6	Provide Flood Protection for MCR HVAC Ducts	A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.	FPIE Importance Lists	\$475,000 (SNC 2003) Farley estimated the cost of sealing MCCs in the cable spreading room to protect them from flood water intrusion - this is used as an approximation for sealing the MCR room cooler units and ducts.	Implementation cost is less than MACR. Retain for Phase II analysis
7	Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose NPSH and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.	FPIE Importance Lists	\$250,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of \$200,000 to \$300,000 for procedure changes that include engineering support and operator testing/training to implement, which is consistent with an EOP change for controlling containment pressure to maintain NPSH and protect containment integrity.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
8	Replace the Inboard Containment Vent AOV with an Environmentally Qualified Valve	A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.	FPIE Importance Lists	$1.828,302 (S&L 2023) CPS-specific cost estimate for valve replacement of the inboard containment isolation valve.$1.339,350 (S&L 2023) CPS-specific cost estimate for valve replacement of the inboard containment isolation valve.	Implementation cost is less than MACR. Retain for Phase II analysis
9	Install Keylock Switch to Override MSIV Low RPV Level Isolation Logic	For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level MSIV isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly. Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.	FPIE Importance Lists	$635,242 (Exelon 2014)	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
10	Install a Hard Piped Connection Between FPS and RHR	Currently, the FPS can be used to inject to the RPV, but it requires significant manual work and time to perform the alignment. The availability of a hard piped connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations.	FPIE Importance Lists Fire Importance Lists	$649,194 (Exelon 2014)	Implementation cost is less than MACR. Retain for Phase II analysis
11	Replace Valves with Versions Designed to Close Against High Flow and Differential Pressure	The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.	FPIE Importance Lists	$600,000 (WCN 2006) The estimate includes replacing two MOVs with improved versions for ISLOCA isolation.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
12	Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed as supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power. A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.	FPIE Importance Lists	$100,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $50,000 to $200,000 for procedure changes that include engineering support or operator testing/training to implement, which is consistent with a procedure change for identifying conditions that would require use of the FLEX generator for conditions specific to containment vent support.	Implementation cost is less than MACR. Retain for Phase II analysis
13	Alternate ECCS Pump Room Cooling	For scenarios involving loss of room cooling to the ECCS pump rooms, perform a room heatup analysis to identify what equipment capabilities would be needed to prevent pump damage on overtemperature given loss of all room cooling (including fans). Provide diverse, portable fan/ductwork that would meet these requirements and maintain room temperature in the acceptable range to allow indefinite operation of the pumps after failure of the normal HVAC system.	FPIE Importance Lists Fire Importance Lists	$399,746 (DEK 2008) Includes room heatup analysis, design changes, addition of high room temp alarms, portable fans, and a procedure change.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
14	Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.	Fire Importance Lists	\$5,629,397 (S&L 2023) CPS-specific cost estimate for protecting cable runs for the ERAT and RAT from the transformers to the protective relay panels, and to the emergency bus feeder breakers.	Implementation cost is less than MACR. Retain for Phase II analysis
15	Install a Battery Backup to the Hydrogen Igniters	While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.	FPIE Importance Lists Fire Importance Lists	\$352,000 (S&L 2023) CPS-specific cost estimate for providing a battery backup to each of the two hydrogen igniter distribution panels.	Implementation cost is less than MACR. Retain for Phase II analysis
16	Squib Valve Bypass Line	Failure of the explosive valves in the SLC injection pathway (squib valves) leads to loss of the ability inject liquid poison in the reactor in a timely manner. Providing a bypass line that includes MOVs would provide a diverse injection pathway.	FPIE Level 2 Importance List	\$716,477 (S&L 2023) CPS-specific cost estimate for installing a new 1 ½ safety related bypass line with a single isolation valve that bypasses the A and B division Squib valves.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
17	Protect the Equipment Required for SRV Operation in the Aux. Building	In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.	FPIE Level 2 Importance List	$701,000 (S&L 2023) This CPS-specific cost estimate addresses the replacement of the outboard containment isolation valves on the IA lines, which is only a subset of the changes required to completely protect the equipment in the Aux Building to maintain SRV operability. Because the cost of this subset of the overall scope obviously exceeded the benefit for this SAMA, the work to address the remaining scope of the SAMA was not pursued.	Implementation cost is less than MACR. Retain for Phase II analysis
18	Install an Emergency RCIC Storage Tank Makeup Capability from Service Water Operable from the MCR	For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a CST makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.	FPIE Level 2 Importance List	$2,900,000 (Exelon 2014) LaSalle estimated the cost of providing a connection from RHRSW to the Core Spray system with remotely operated MOVs. This is considered to be similar in scope to the CPS SAMA with the major difference being that the makeup line goes to the RCIC storage tank rather than LPCS.	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
19	Modify FLEX Procedure for FPS Makeup to the RCIC Storage Tank to Allow Use in Non-ELAP Scenarios	For cases in which SP cooling is not available, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RCIC injection for a longer time without SPC.	Level 1 Fire Importance List	\$100,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of \$50,000 to \$200,000 for procedure changes that include engineering support or operator testing/training to implement, which is consistent with a procedure change for identifying conditions that would require use of the FLEX pumps for non-ELAP conditions.	Implementation cost is less than MACR. Retain for Phase II analysis
20	Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.	Level 1 Fire Importance List	\$8,000,000 (NMC 2008)	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.5-3
CPS Phase 1 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
21	Address Flow FW Diversion in the Loss of Instrument Air Procedure	Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.	Industry SAMA list	\$30,000 (CEG 2004)	Implementation cost is less than MACR. Retain for Phase II analysis
22	Upgrade the alternate shutdown panel to include additional system control for the opposite division	The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.	Industry SAMA list	\$790,000 (Entergy 2017)	Implementation cost is less than MACR. Retain for Phase II analysis

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
1	Provide Portable HVAC Equipment and Supporting Procedures for Alternate DG Room Cooling	For scenarios involving loss of room cooling for the EDGs, providing a diverse, portable fan/ductwork to indefinitely maintain room temperature in the acceptable range would prevent SBO/loss of 4KV power due to HVAC failures.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
2	Proceduralize DC Current Check for ELAP Load Shed Action	Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.	FPIE Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
3	Protect the RCIC Storage Tank, Provide Long Term Makeup, and Support Containment Venting for Heat Removal	While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control (procedure changes to use FLEX generator assumed to be required in some cases) would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
4	Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
5	Install an Emergency Tie Line From the Switchyard to an Emergency Bus	The process to restore offsite AC power to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
6	Provide Flood Protection for MCR HVAC Ducts	A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
7	Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose NPSH and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.	FPIE Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
8	Replace the Inboard Containment Vent AOV with an Environmentally Qualified Valve	A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
9	Install Keylock Switch to Override MSIV Low RPV Level Isolation Logic	For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level MSIV isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly. Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
10	Install a Hard Piped Connection Between FPS and RHR	Currently, the FPS can be used to inject to the RPV, but it requires significant manual work and time to perform the alignment. The availability of a hard piped connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
11	Replace Valves with Versions Designed to Close Against High Flow and Differential Pressure	The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
12	Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed as supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power. A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.	FPIE Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
13	Alternate ECCS Pump Room Cooling	For scenarios involving loss of room cooling to the ECCS pump rooms, perform a room heatup analysis to identify what equipment capabilities would be needed to prevent pump damage on overtemperature given loss of all room cooling (including fans). Provide diverse, portable fan/ductwork that would meet these requirements and maintain room temperature in the acceptable range to allow indefinite operation of the pumps after failure of the normal HVAC system.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
14	Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.	Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
15	Install a Battery Backup to the Hydrogen Igniters	While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
16	Squib Valve Bypass Line	Failure of the explosive valves in the SLC injection pathway (squib valves) leads to loss of the ability inject liquid poison in the reactor in a timely manner. Providing a bypass line that includes MOVs would provide a diverse injection pathway.	FPIE Level 2 Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
17	Protect the Equipment Required for SRV Operation in the Aux. Building	In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.	FPIE Level 2 Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
18	Install an Emergency RCIC Storage Tank Makeup Capability from Service Water Operable from the MCR	For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a CST makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.	FPIE Level 2 Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
19	Modify FLEX Procedure for FPS Makeup to the RCIC Storage Tank to Allow Use in Non-ELAP Scenarios	For cases in which SP cooling is not available, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RCIC injection for a longer time without SPC.	Level 1 Fire Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
20	Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.	Level 1 Fire Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
21	Address Flow FW Diversion in the Loss of Instrument Air Procedure	Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.	Industry SAMA list	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table F.6-1
CPS Phase 2 SAMA List Summary

SAMA Number	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
22	Upgrade the alternate shutdown panel to include additional system control for the opposite division	The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.	Industry SAMA list	This SAMA's net value is negative and is classified as not "cost-beneficial".

F.10 FIGURES

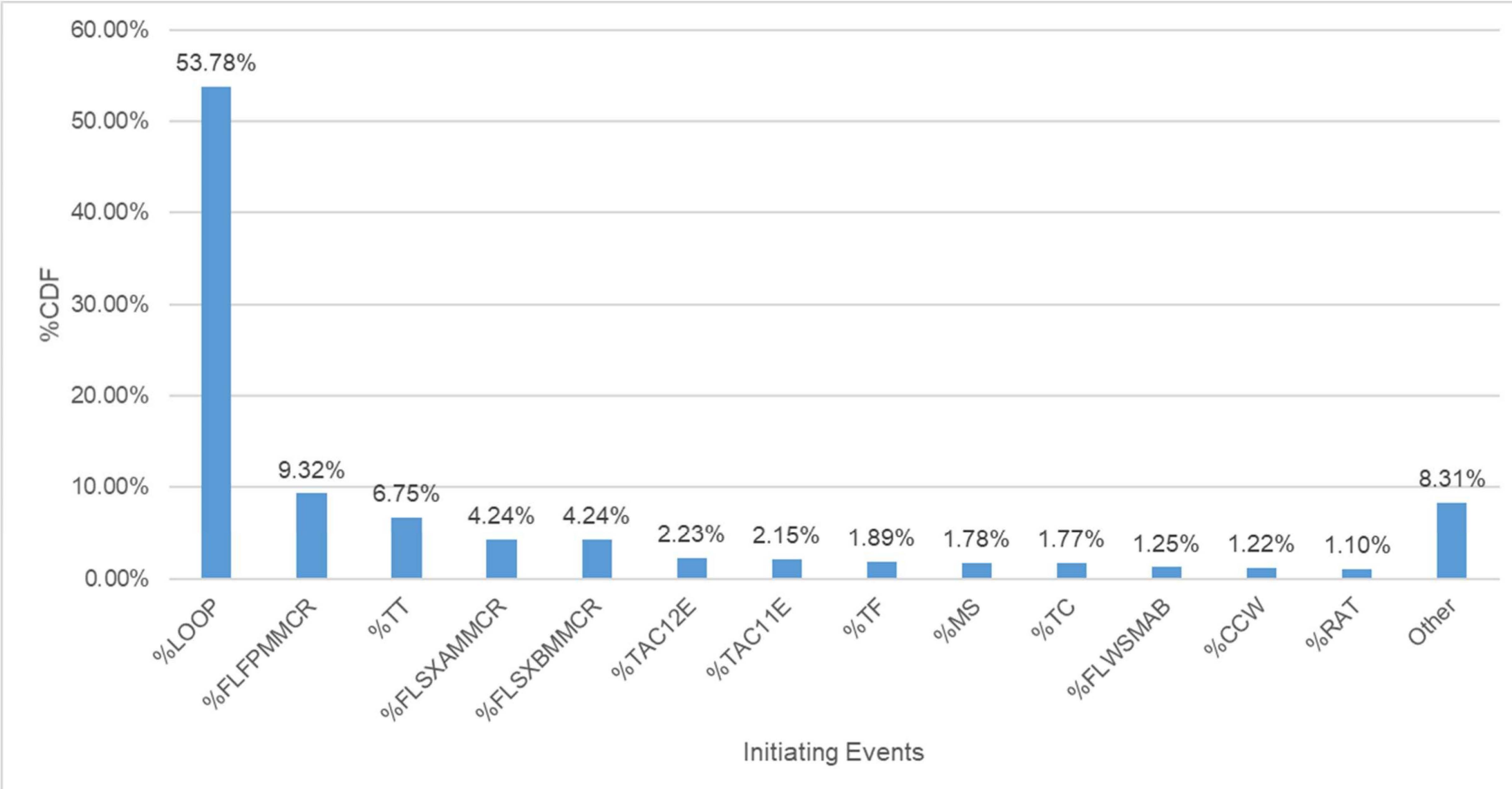

Figure F.2.3.1-1
Clinton FPIE CDF Results by Initiating Event

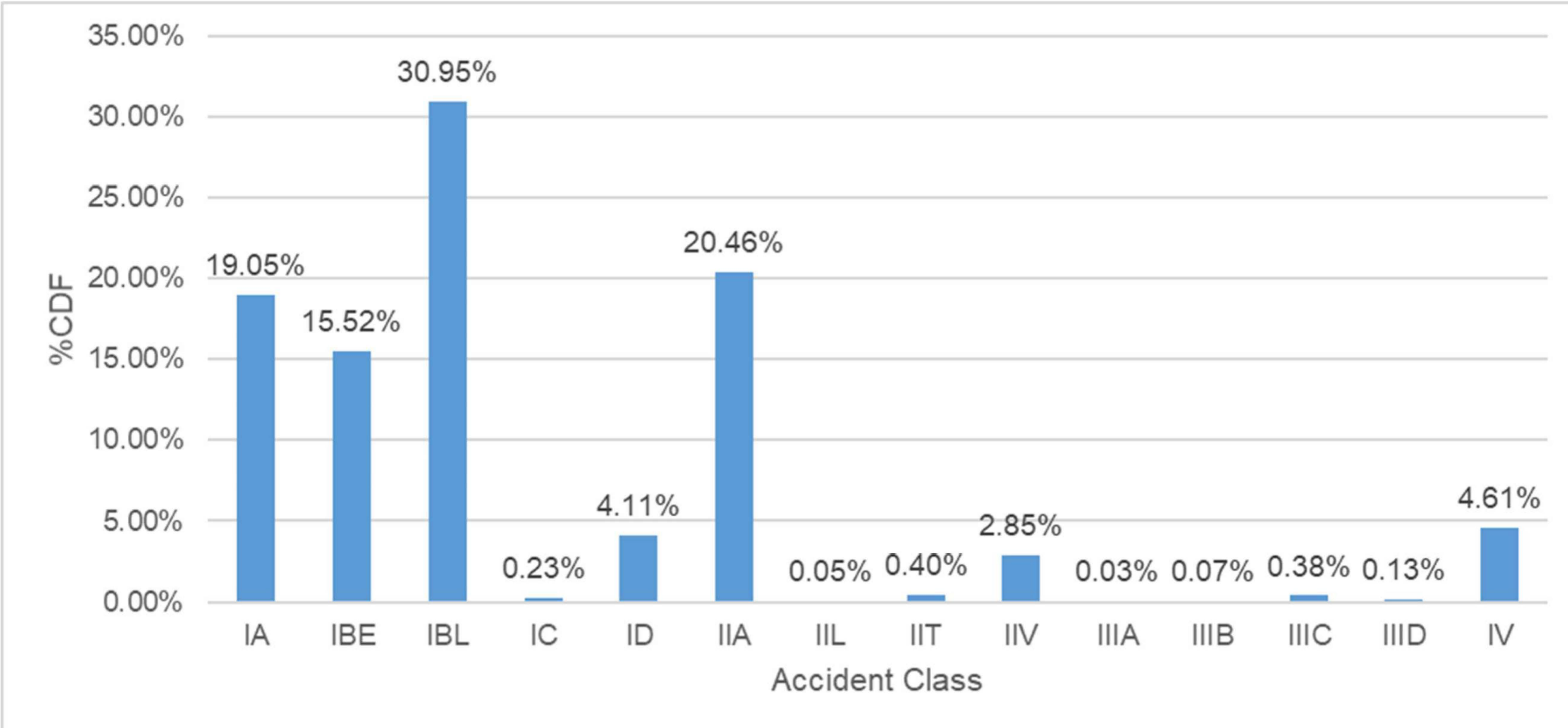

Figure F.2.3.1-2
Clinton FPIE CDF Results by Accident Class

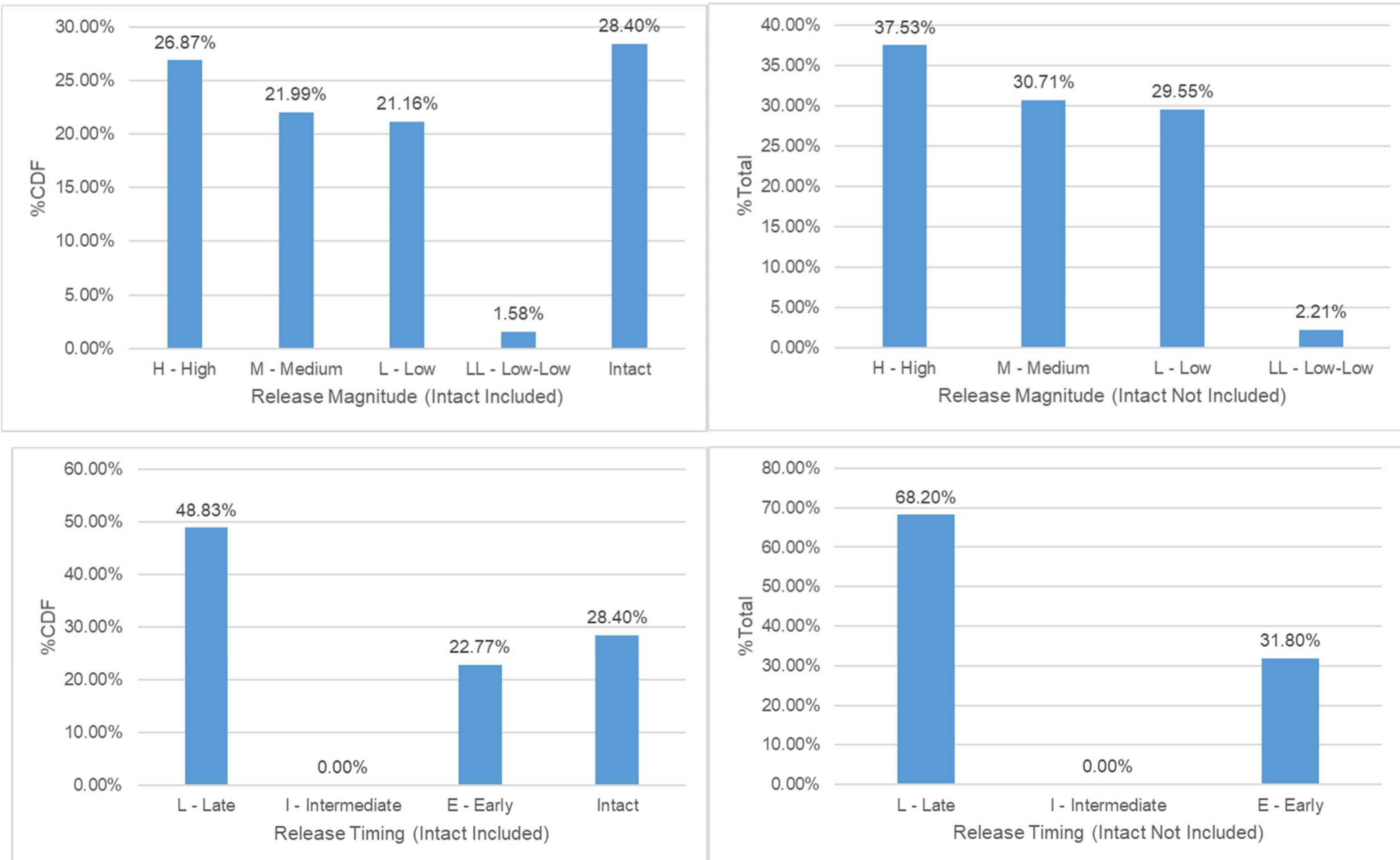

Figure F.2.3.2-1
Clinton FPIE Level 2 Results by Radionuclide Release Timing

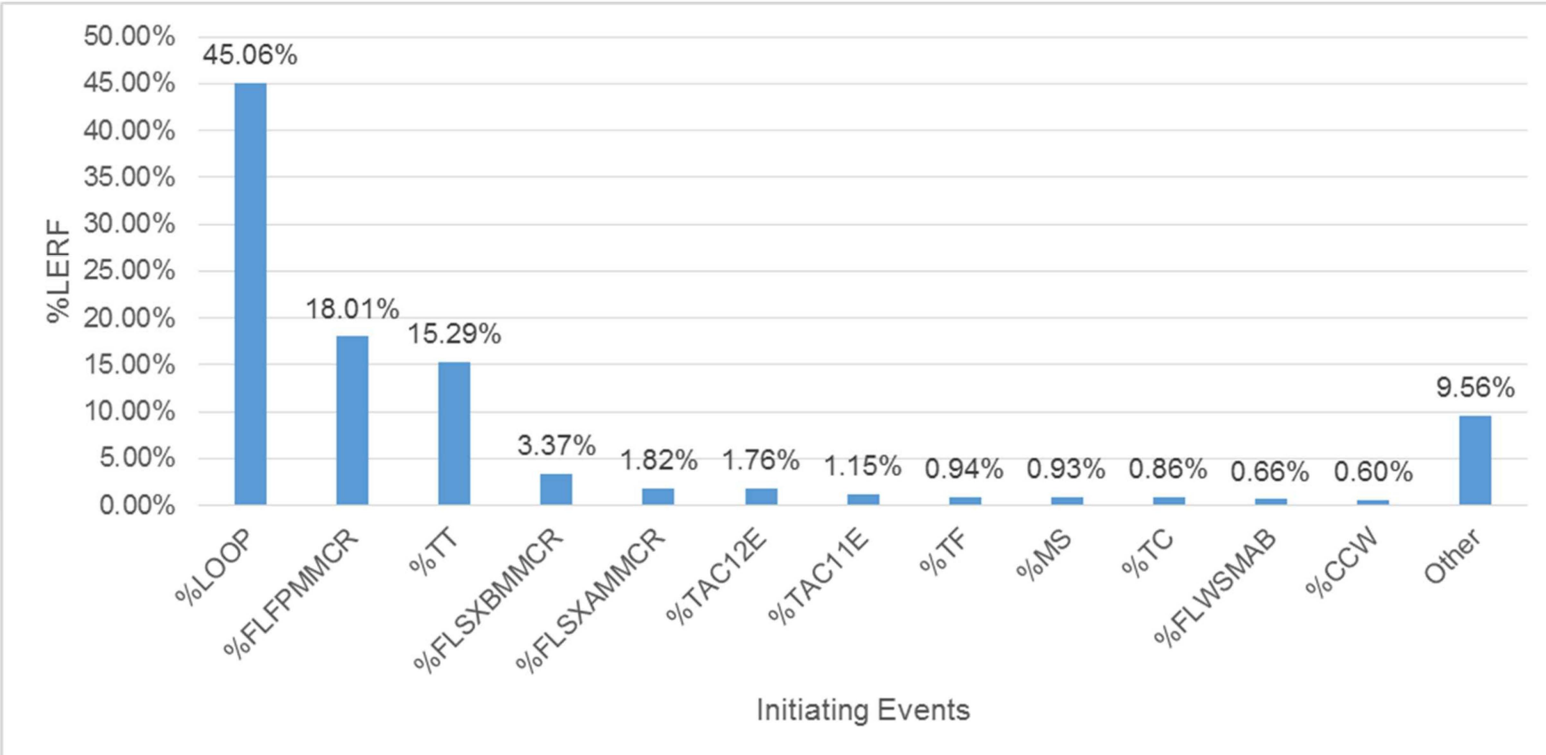

Figure F.2.3.2-2
Clinton FPIE LERF Results by Initiating Event

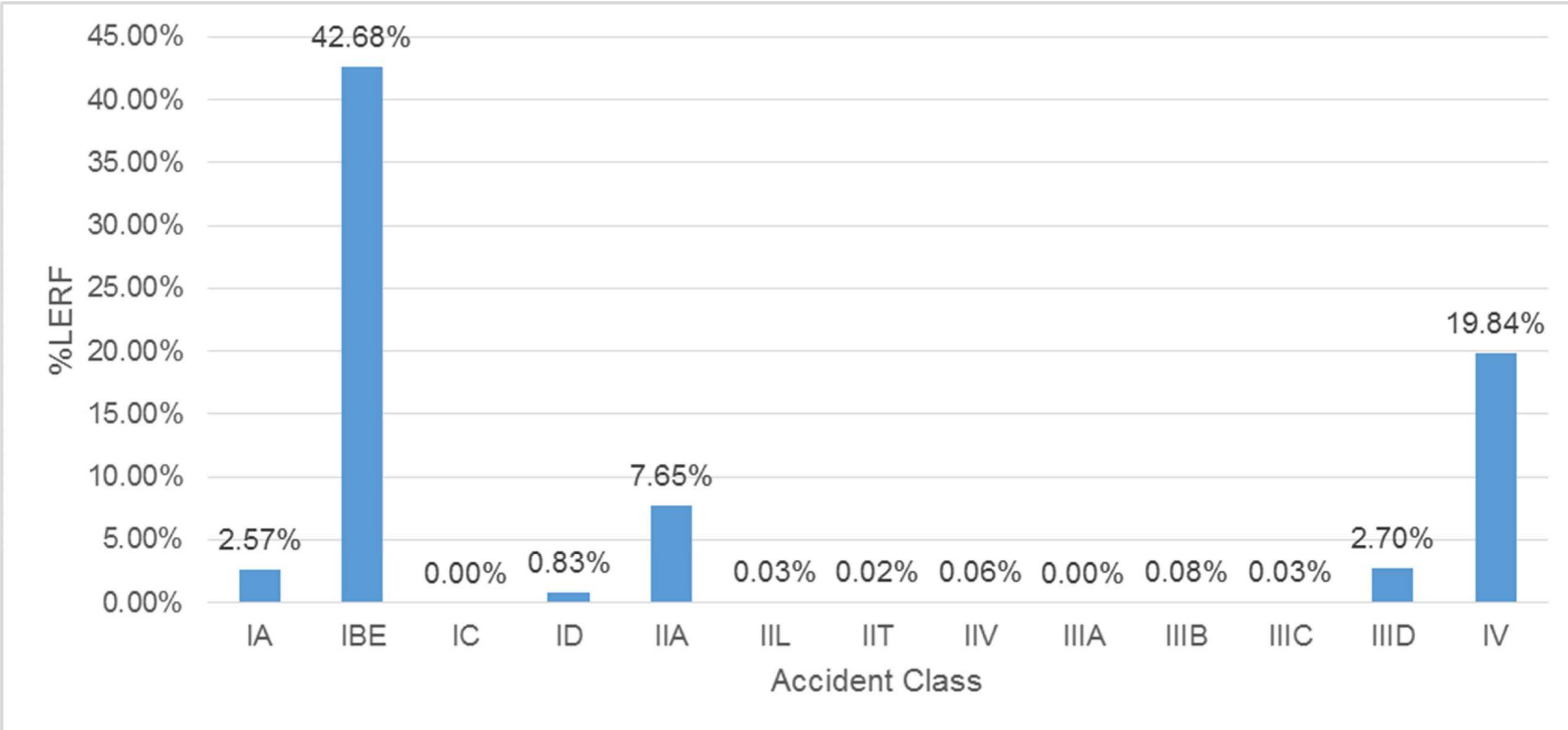

Figure F.2.3.2-3
Clinton FPIE LERF Results by Accident Class

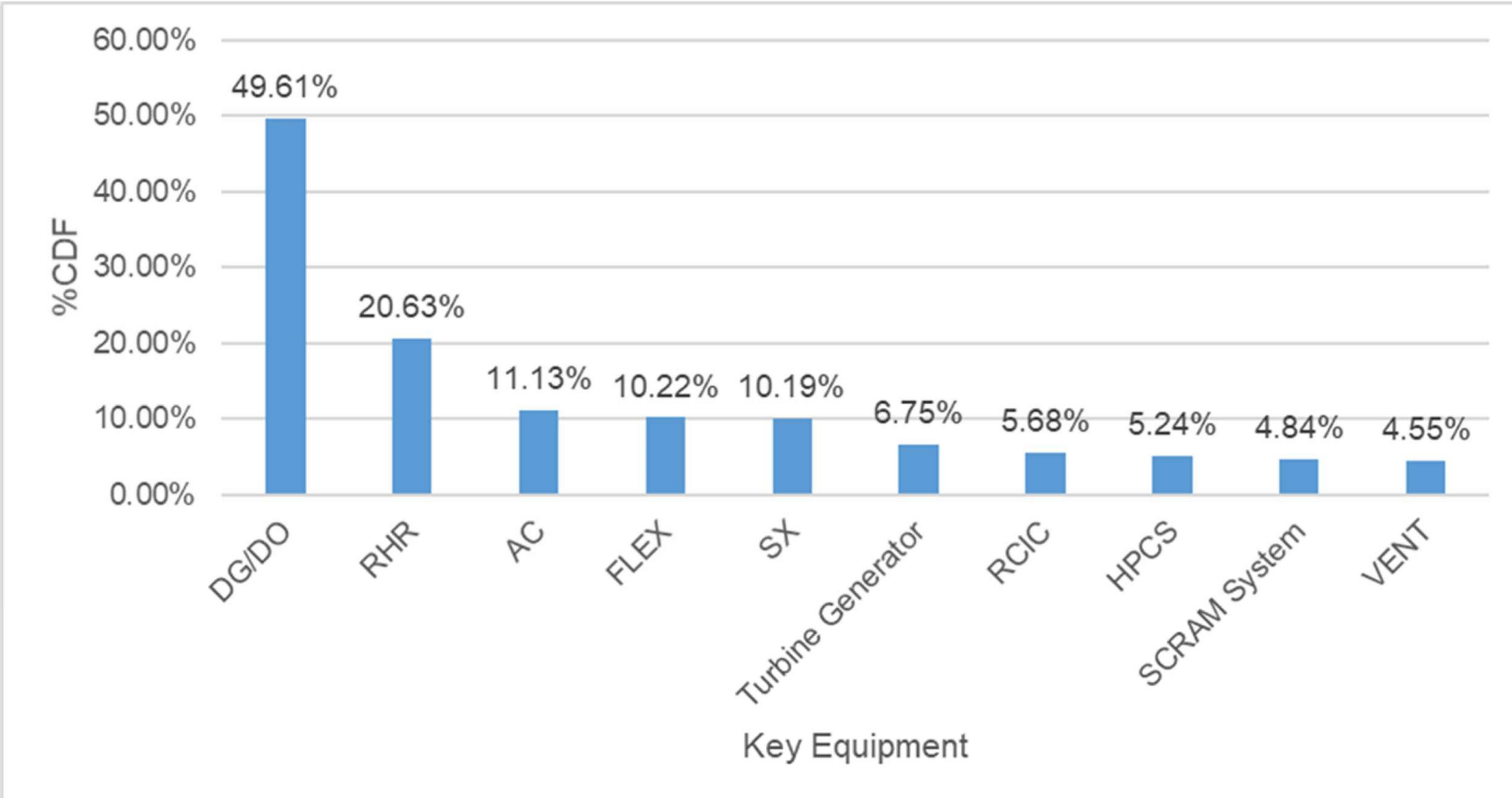

Figure F.2.3.3-1
Clinton FPIE CDF Results by Key Equipment

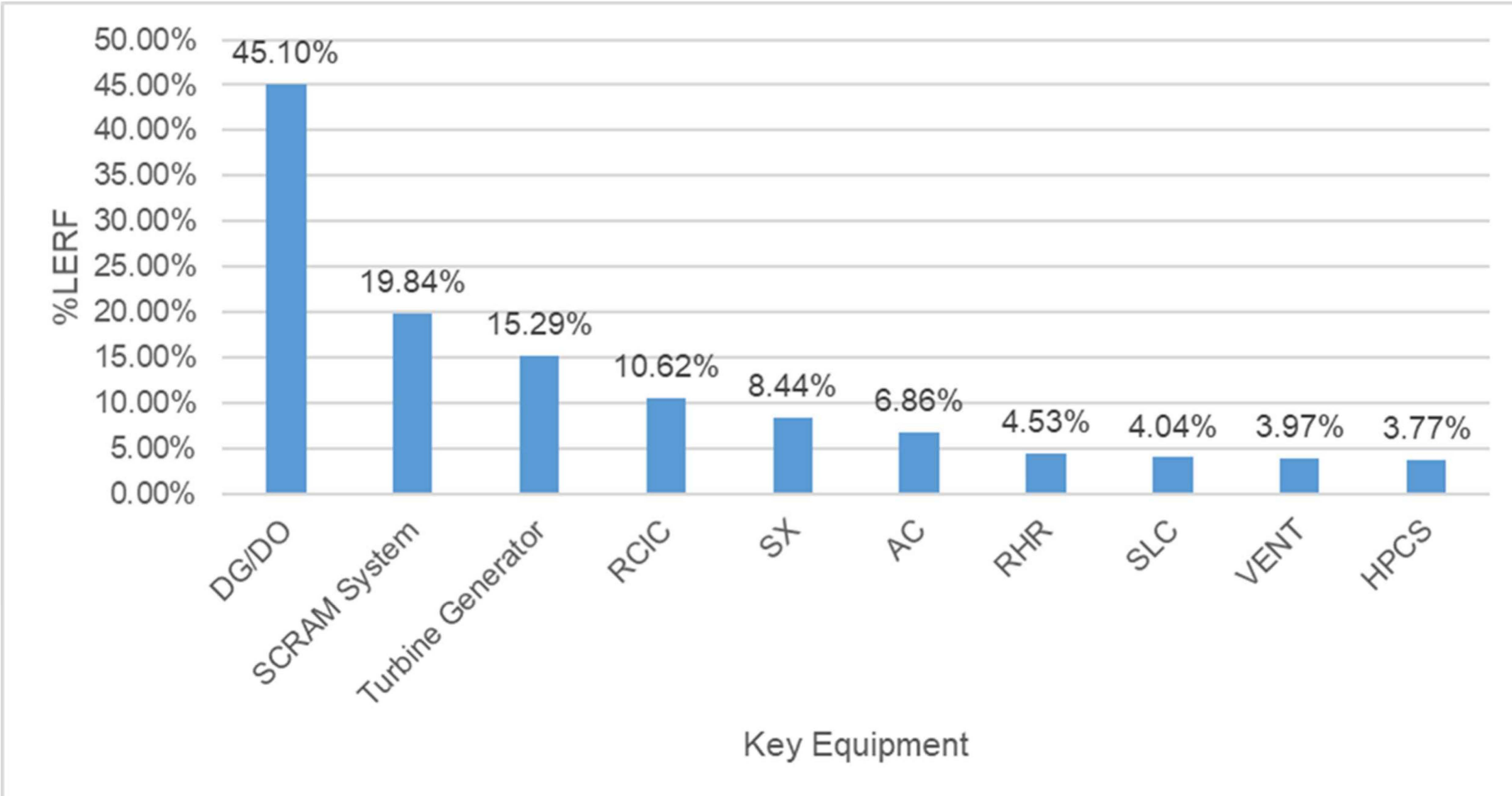

Figure F.2.3.3-2
Clinton FPIE LERF Results by Key Equipment

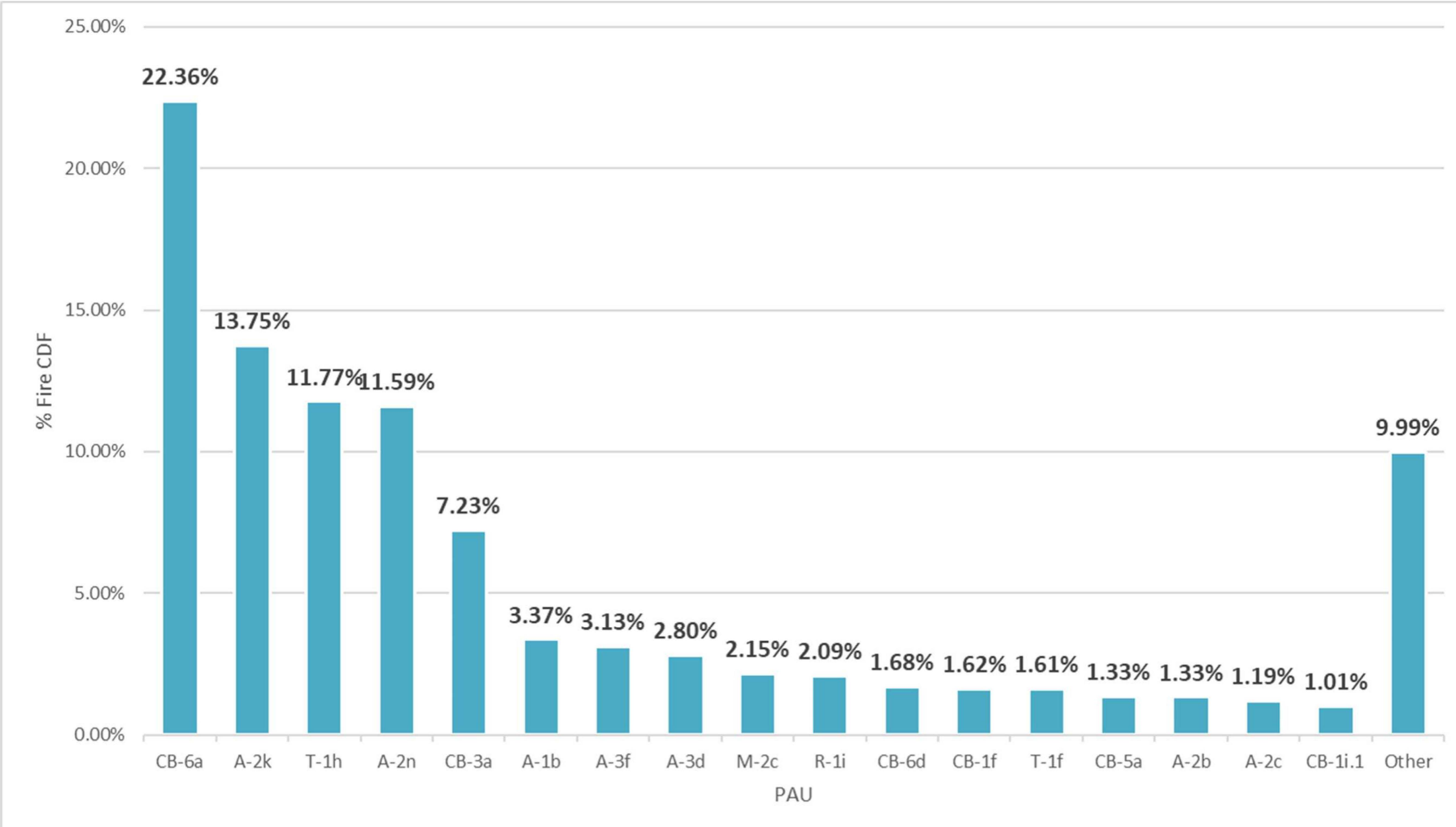

Figure F.2.4.1-1
Clinton Fire CDF Results by PAU

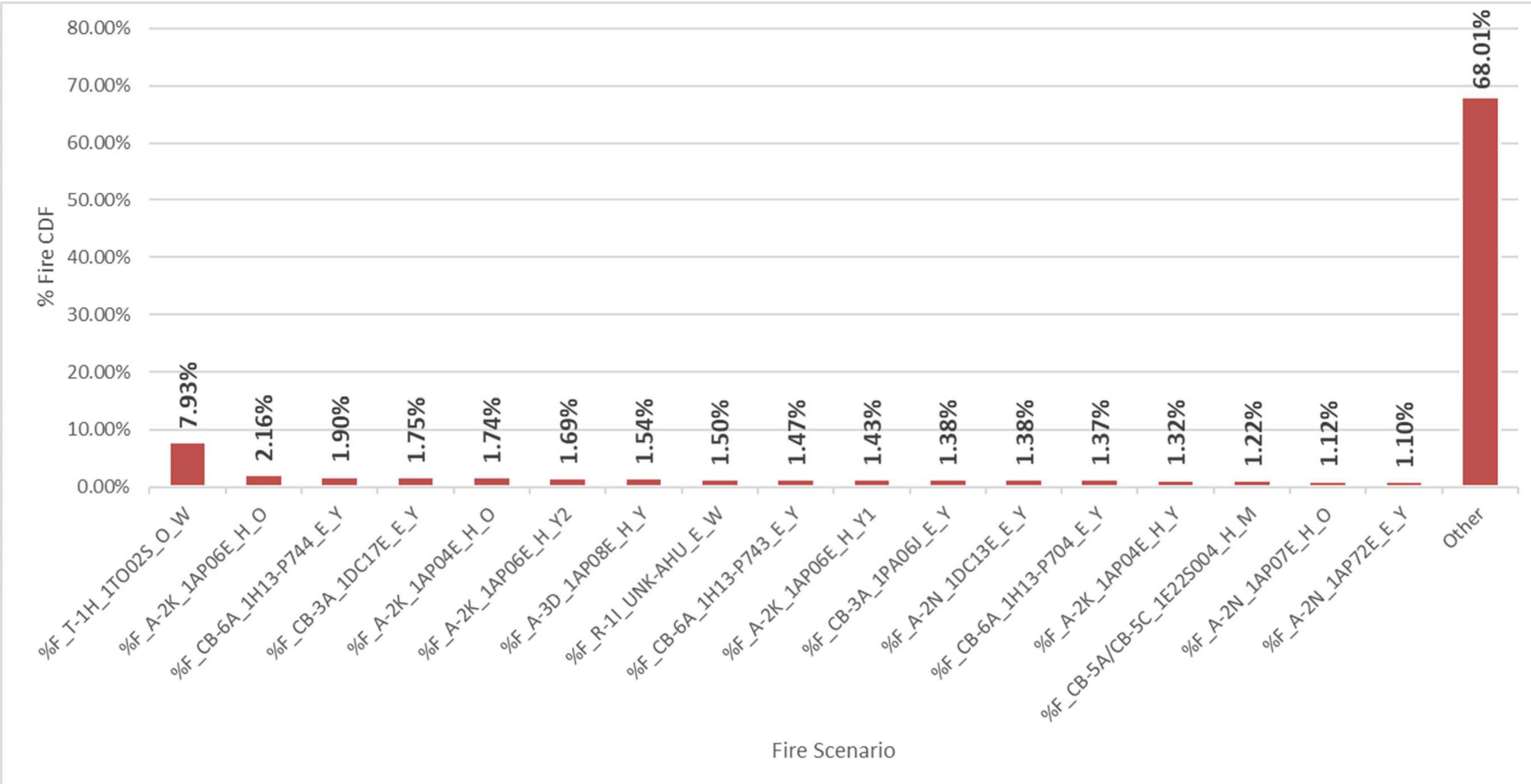

Figure F.2.4.1-2
Clinton Fire CDF Results by Fire Scenario

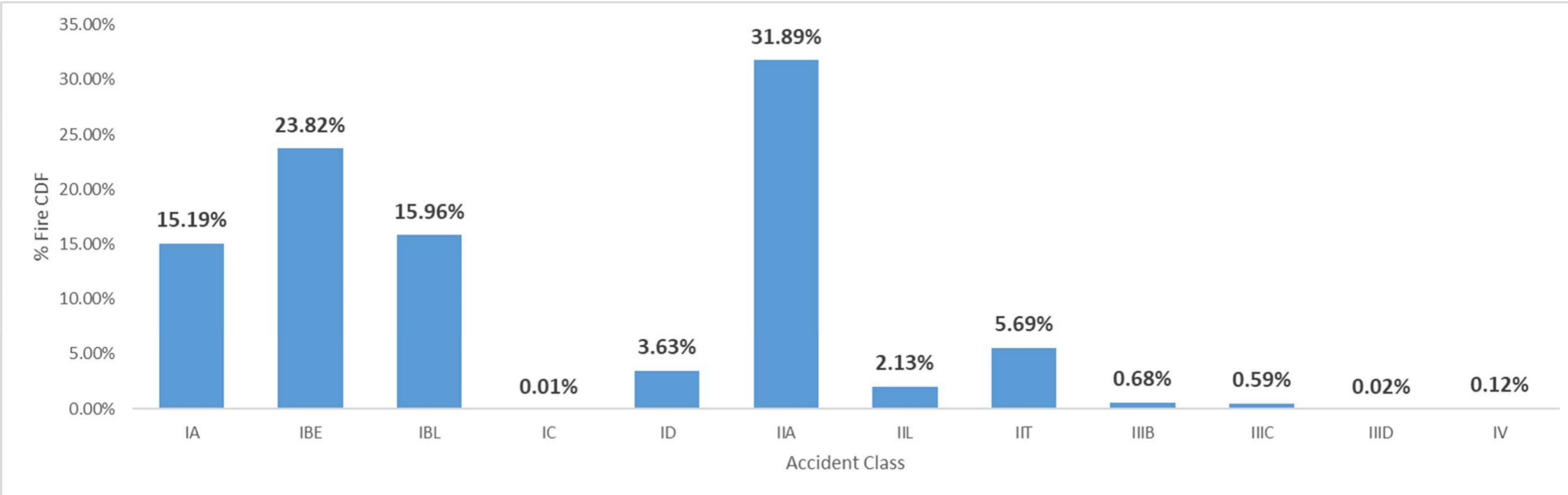

Figure F.2.4.1-3
Clinton Fire CDF Results by Accident Class

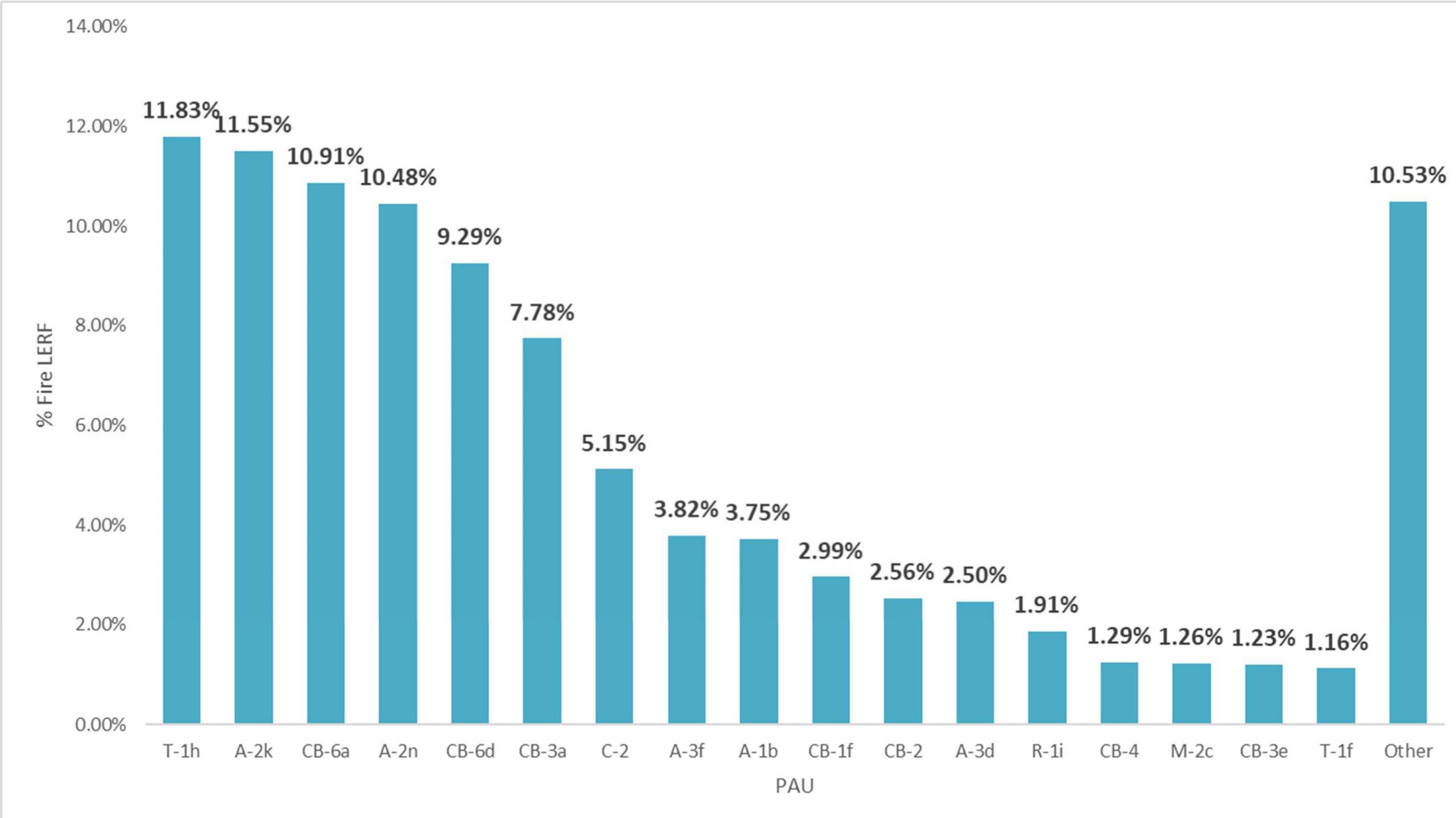

Figure F.2.4.2-1
Clinton Fire LERF Results by PAU

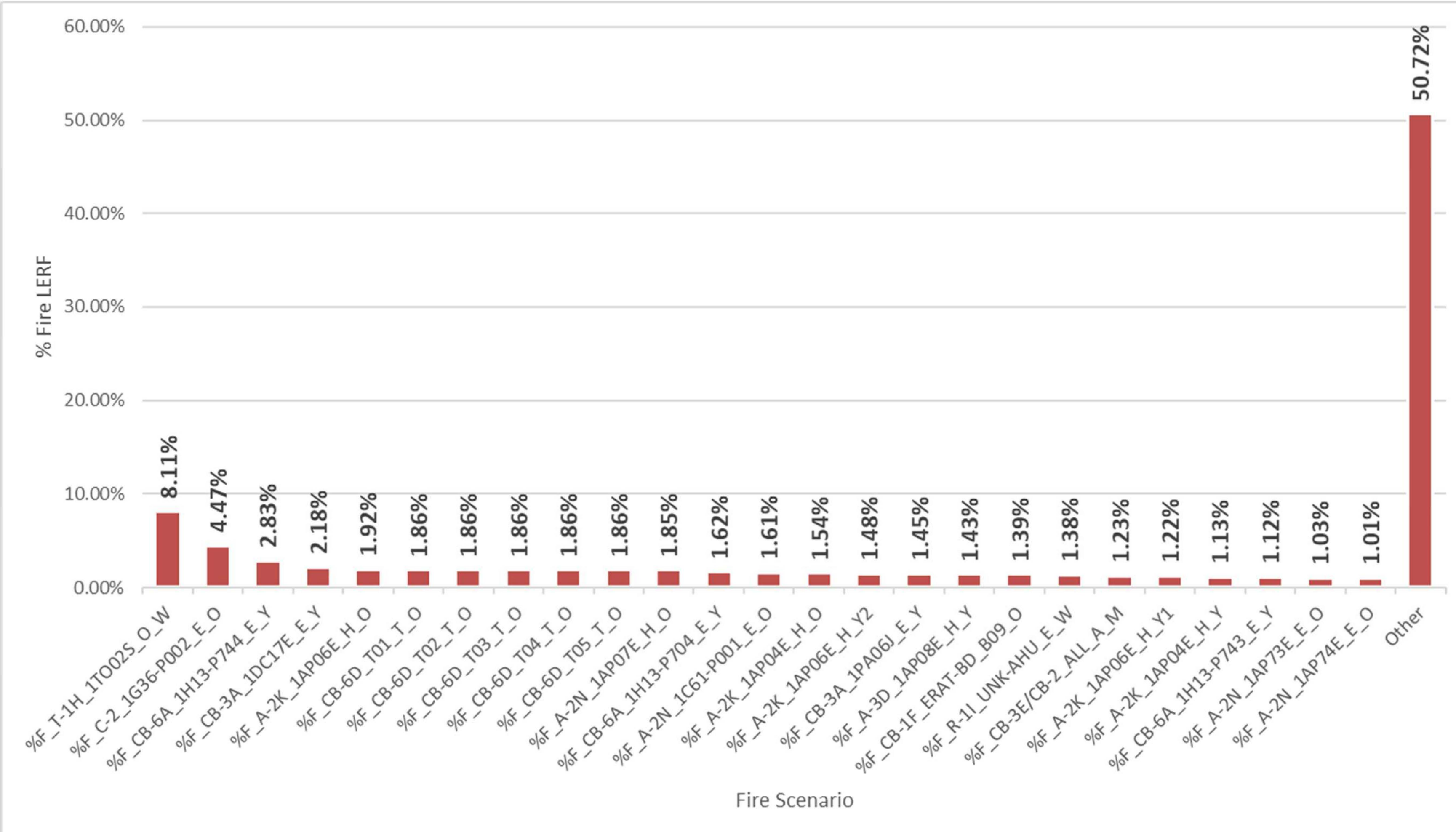

Figure F.2.4.2-2
Clinton Fire LERF Results by Fire Scenario

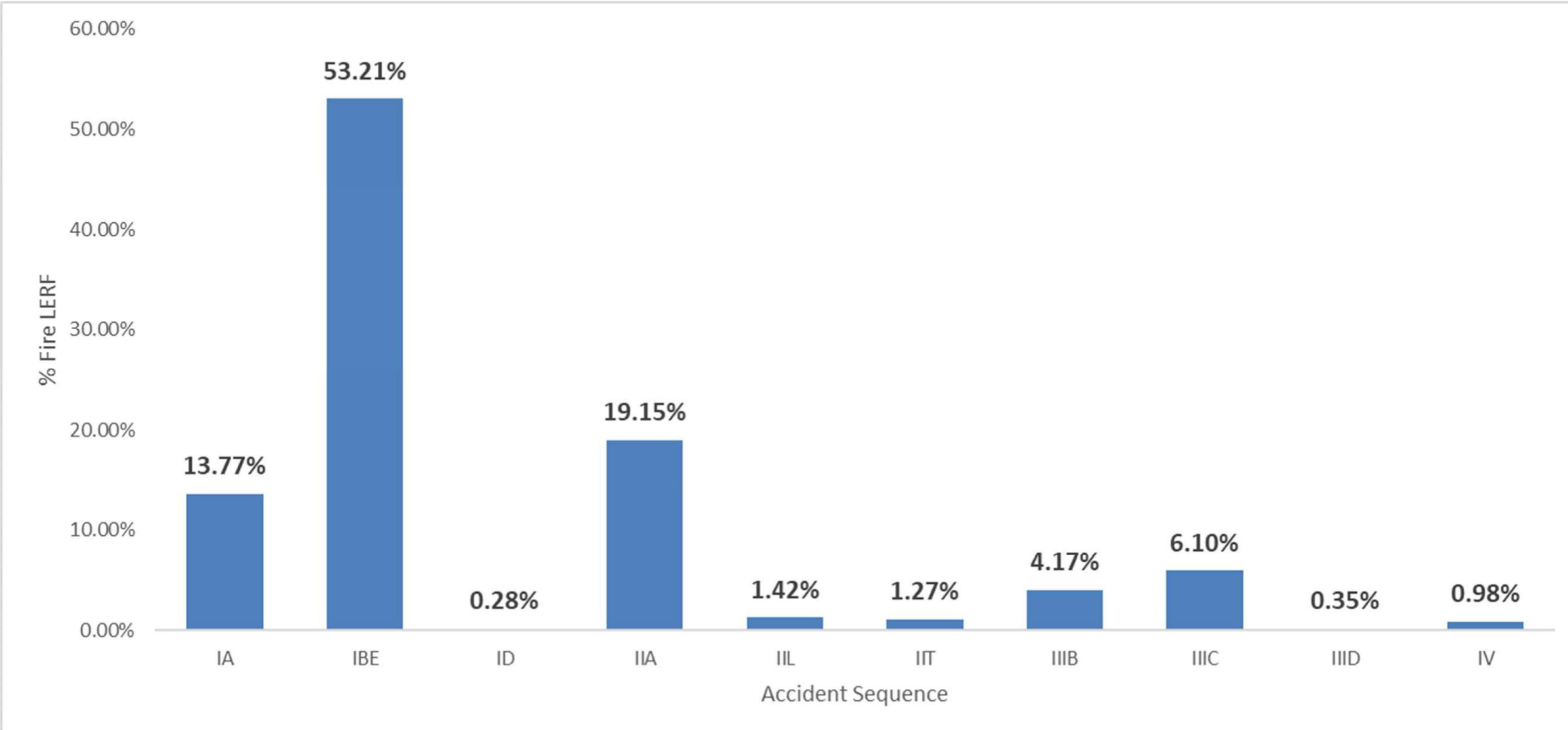

Figure F.2.4.2-3
Clinton Fire LERF Results by Accident Class

Legend:

HE – High Early

HI – High Intermediate

ME – Medium Early

MI – Medium Intermediate

LE – Low Early

LI – Low Intermediate

LLE – Low-low Early

LLI – Low-low Intermediate

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Addendum 1: Base PRA Model Changes for SAMA Analysis

Overview

As discussed in Attachment F.2, the FPIE PRA model (CL117B) and Fire PRA model (CL117BF0) were slightly modified to support the SAMA analysis. This attachment summarizes those PRA model changes.

In general, the changes made to the model were focused on improving the quantification speed of the models and correcting a few Level 2 Containment Event Tree (CET) success branch probabilities used in non-LERF Level 2 release categories.

FPIE Model Changes

The following model changes were made to the FPIE PRA model (CL117B):

- Software: PRAQuant v5.2 is used instead of v5.1a.

No other model changes were made for the FPIE PRA model.

Fire PRA Model Changes

The following model changes were made to the Fire PRA model (CL117BF0):

- Software: PRAQuant v5.2 is used instead of v5.1a. Additionally, ACUBE (1,000 cutsets) was used for the fire quantification.
- EDG Mission Time: In the base fire flag file, the emergency diesel generator (EDG) fail to run (FTR) and fail to start (FTS) independent failure probabilities and associated common cause failure (CCF) probabilities are set to higher values based on the Fire PRA model using a 24 hour mission time (the FPIE model uses an 8 hour mission time). Rather than treating these in a flag file, the fire RR database file was modified to use the 24 hour mission time in the probability calculations.

  Therefore, the following events were removed from the fire flag file and these events were modified in the RR database to use the 24 hour mission time:

1DGDG-DG01KA-X--	*1DGDG--DGAB--XCC*
1DGDG-DG01KB-X--	*1DGDG--DGBC--XCC*
1DGDG-DG01KC-X--	*1DGDG--DGAC--XCC*
	1DGDG-DGABC--XCC

  Additionally, the CCF events (*CC) were removed from the fire recovery file as they are now modified in the RR database. In the base Fire PRA, the CCF events are set to 1.0 in the flag file and then set to the appropriate probability in the recovery file. Since the RR database has been modified to use the correct mission time, the recovery file no longer needs to set the final CCF probability.

- Level 2 CET Success Branch Probabilities: A review of the Level 2 fire results indicated that the CET success branch probabilities for the RX node (RPV remains intact: core melt progression arrested in-vessel) and the SI node (injection established to RPV or drywell) for Class 1B accident sequences (i.e., station blackouts) were set to 1.0 instead of 0.0. For a fire-induced loss of offsite power (LOOP), offsite power is not recoverable, so the success branches should be set to 0.0 (or FALSE). Therefore, the fire flag file was modified to include the following events set to FALSE:

  1RXPH-RX4-NOTFSU

  1SIPH-SI3-NOTFSU

  1SIPH-SI4-NOTFSU

Results

Table F-1 summarizes quantification results of the modified FPIE and Fire PRA models as compared to the previous models (i.e., CL117B and CL117BF0). FPIE CDF & LERF were quantified at 5E-12/yr truncation and Fire CDF and LERF were quantified at 5E-11/yr truncation.

Table F-1
SAMA Model Quantification Results (Baseline)

Case	Truncation	CDF (/yr)	No. of Cutsets	%CDF Change	LERF (/yr)	No. of Cutsets	%LERF Change
FPIE							
Base (CL117B)	5.00E-12	2.91E-06	53,467	-	1.22E-07	2,060	-
SAMA Model	5.00E-12	2.91E-06	53,488	0.00%	1.22E-07	2,060	0.00%
Fire							
Base (CL117BF0)	5.00E-11	7.75E-05	80,133	-	4.58E-06	9,905	-
SAMA Model	5.00E-11	7.76E-05	81,044	0.13%	4.60E-06	10,088	0.44%

As shown in Table F-1, the FPIE PRA model results are essentially unchanged (only 21 new cutsets added to the CDF results due to the use of a new version of PRAQuant). Additionally, the Fire PRA model results are essentially unchanged even though ACUBE was used for 1,000 cutsets. As previously stated, these model changes were mostly performed to improve quantification speed and correct Level 2 probabilities in the Fire PRA.

Attachment F, Addendum 2

Impact of CPS MOR CL122A/CL122AF0 on the Severe Accident Mitigation Alternatives Analysis

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Overview

The CL117B (full power internal events and internal flooding) & CL117BF0 (internal fires) models, which were developed during the 2017B PRA update, were used to perform the Clinton SAMA analysis because they were the Models of Record at the time the project was initiated. However, the 2022 PRA update has been completed and this Addendum has been developed to document the impacts of the 2022 PRA update on the CPS SAMA Analysis.

1.0 METHODOLOGY

The same methodology used in the SAMA analysis and documented in Attachment F, Section F.1 of the Environmental Report was used to evaluate the impact of the new model on the SAMA analysis.

2.0 CPS PRA MODEL

The purpose of this section is to summarize the key aspects of the CPS PRA models developed as part of the 2022 PRA update, including their development, quantitative results, and insights from the CPS PRA 2022 full power internal events (FPIE) and Fire PRA updates. The CPS FPIE PRA model (CL1122A) and the Fire PRA model (CL122AF0) model are used to support the SAMA analysis. Both models can quantify the core damage frequency (CDF) and a full range of Level 2 release categories, including the large early release frequency (LERF). However, CDF and LERF are the only risk metrics that are analyzed in detail as part of the model of record (MOR).

The Level 1 PRA quantifies the frequency of severe accidents that may compromise mitigative and preventive engineering safety features and, ultimately, cause damage to the nuclear reactor core. The primary result of a Level 1 PRA is quantification of the CDF based on initiating events analysis, scenario development, system analyses, and human-factor evaluations.

The CPS Level 1 PRA addresses internal events, including flooding and loss of off-site power. External events such as fires, seismic, tornadoes and external flooding, which were analyzed separately in response to NRC Generic Letter 88-20, Supplement 4 (NRC 1991) are also addressed separately from the internal events risk in the SAMA analysis (refer to sections 4.6.2 and 5.1.6).

The mitigating systems referred to in the Level 1 logic model are those which shut down the reactor, provide core cooling to prevent overheating (or, ultimately, fuel melting), or provide containment heat removal. Any support systems that are necessary for the front-line systems to be successful are also included within the Level 1 scope.

The Level 1 logic model is developed to display and provide a calculational vehicle for the critical safety functions to mitigate these initiating events and to estimate the overall core damage frequency. The basic concept of a Level 1 PRA is simple. However, the large number of initiating events, systems, components, and human interactions associated with nuclear plant operation and maintenance, make the performance of the Level 1 PRA analysis complex.

The CPS PRA model is updated periodically in accordance with internal Constellation procedures to reflect plant modifications, procedure changes, and the plant-specific failure data and maintenance unavailability for major plant components.

2.1 PRA UPDATE FREEZE DATE

The CL122A PRA model is an update to the 2017B Clinton PRA update (CL117B). The freeze date for plant modifications for the 2022 Clinton PRA update was December 31, 2021.

The Emergency Operating Procedures (EOPs) and Severe Accident Guidelines (SAGs) used in this analysis are those in place as of the freeze date.

2.2 PRA HISTORY

The Clinton Power Station (CPS) PRA model and documentation have been regularly maintained and are periodically updated to reflect the current plant configuration and the accumulation of additional plant operating history and component failure data. The Level 1 and Level 2 CPS PRA analyses were originally developed and submitted to the NRC in September 1992 as the Clinton Power Station Individual Plant Examination (IPE) Submittal in response to NRC Generic Letter 88-20. The CPS PRA has been updated many times since the original IPE and a complete history is summarized in the CPS PRA Summary Notebook (PRA FPIE 2020).

The 2022 PRA update was the result of the scheduled PRA update (i.e., periodic update per Constellation Risk Management T&RMs). The 2022 PRA update was a comprehensive update of the FPIE and Fire PRA models that incorporated a variety of changes to the Level 1 and Level 2 PRA. These changes include, but are not limited to the following:

- Migration to Phoenix Architect v.1.0b software.
- Bayesian updated initiating event frequencies utilizing the most recent Clinton operating experience and the most current generic data.

- Bayesian updated component failure rate probabilities utilizing plant-specific component failure data gathered from the site (when available) and the most current generic data.
- Updated maintenance unavailability data based on the most recent LaSalle operating experience.
- Revised common cause failure (CCF) calculations to incorporate the updated individual random component failure probabilities and the most current CCF generic data.
- Reviewed and updated (as necessary) the human failure events (HFEs) were to incorporate new insights from the EPG/SAG Rev. 4 changes reflected in the current procedures. Minor changes in human error probabilities (HEPs) were observed. Some new HFEs were added to the model.
- Updated the HRA Dependency Analysis to reflect the new HFEs added to the 2022 PRA model.
- Added a new internal flooding initiator (%FLVCMMCR) based on a flood source that was inadvertently missed during initial scenario development.
- Incorporated open phase condition (OPC) into the PRA model. This model change also implemented the split bus configuration for the safety-related 4.16kV buses (i.e., 2 buses normally aligned to RAT, 1 bus normally aligned to ERAT).
- Removed loss of RAT initiating event (%RAT) as it is no longer a valid initiating event.
- Refinement of RPS logic (now divisionalized) for RICT.
- Fire PRA Only: Incorporated recent Fire PRA industry guidance documented in NUREG-2178, Vol. 2 and NUREG-2230.
- Fire PRA Only: Incorporated a more realistic treatment of secondary combustibles for fire modeling.
- Fire PRA Only: Performed a Focused-Scope Peer Review (FSPR) on PRA Standard Technical Element (TE) Fire Scenario Selection (FSS).

2.3 FPIE MODEL OVERVIEW

2.3.1 FPIE LEVEL 1 Results

The core damage frequency (CDF) model provides a tool for estimating the likelihood or frequency of core damage. Because consequences of a core damage event can range from minimal (as in the case of the Three Mile Island event in 1979) to more severe (as in the case of the Fukushima event in 2011), additional information is needed to assess risk.

The CDF for the CL122A FPIE PRA model is calculated using the single-top model in CAFTA at a truncation of 1E-12/yr. The CL122A Level 1 CDF is 2.00E-06/yr.

Additional details related to the CL122A Level 1 model are provided in the following subsections:

- 2.3.1.1: CDF Contribution by initiating event.
- 2.3.1.2: CDF Contribution by accident class.

2.3.1.1 FPIE CDF Contribution by Initiating Event

Table 2.3.1-1 summarizes the FPIE CDF contributors by initiating event. Figure 2.3.1-1 presents the results as a bar chart.

Loss of offsite power (LOOP) is the dominant initiating event as they represent a major loss of mitigating events that places a high importance on the emergency diesel generators. Additionally, internal floods in the area above the Main Control Room (MCR) are significant as they can flood the control room and cause operators to abandon the MCR and use the Remote Shutdown Panel (RSDP).

2.3.1.2 FPIE CDF Contribution by Accident Class

Table 2.3.1-2 summarizes the FPIE CDF contributors by accident class. Figure 2.3.1-2 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~37% of the CDF is attributed to Class IA, which involves a loss of inventory makeup in which the reactor pressure remains high. The next highest contributors to CDF are Class IBL (~21%; station blackout with loss of coolant inventory makeup in the late (>4 hours) timeframe), Class IIA (~12.5%; loss of containment heat removal with the RPV initially intact and core damage is induced post-containment failure), and Class IBE (~9.5%; station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe).

2.3.2 FPIE LEVEL 2 Results

The Level 2 PRA model is designed to identify underlying causes of containment failure for severe accidents and the associated release pathways and their frequencies. Specifically, the Level 2 PRA determines the release frequency, severity, and timing of postulated releases based on the Level 1 PRA, accident progression analysis, and containment performance.

The Level 2 PRA includes two types of analyses: (1) a deterministic analysis of the physical processes for a spectrum of severe accident progressions, and (2) a probabilistic analysis component in which the likelihood of the various outcomes is assessed. The deterministic analysis examines the response of the containment to the physical processes associated with a severe accident. Containment response is modeled by: (1) using the Modular Accident Analysis Program (MAAP) code to simulate severe accidents that have been identified as dominant contributors to core damage in the Level 1 analysis, and (2) performing reference calculations for hydrodynamic and heat transfer phenomena that occur during the progression of a severe accident.

The Level 2 PRA is based on a containment event tree (CET) model. The CET represents an accident progression given initial plant damage states and is a logic model with functional nodes that represent sequential phenomenological events and the status of containment protection systems. The CET provides the framework for evaluating containment failure modes and conditions that would affect the magnitude of the release.

The CPS CETs allow core damage scenarios defined in the Level 1 model to be further developed into consequence bins. Separating scenarios this way allows results of plant risk calculations to be presented in simple, meaningful terms. Consequence bins are based on the severity of the source term and the timing of the release relative to the time a general emergency is declared and then initiation of protective actions for the public. The characteristics of these bins are then used as input for the Level 3 model. The following subsections summarize the breakdown of the bins and the Level 2 results.

The LERF for the CL122A FPIE PRA model is calculated using the single-top model in CAFTA at a truncation of 1E-13/yr. The CL122A Level 2 LERF is 7.31E-08/yr.

The following subsections summarize the breakdown of the bins and the Level 2 results.

- 2.3.2.1: Consequence Bins: Source Term Severity.
- 2.3.2.2: Consequence Bins: Timing of Release.
- 2.3.2.3: Level 2 Radionuclide Release Categories.
- 2.3.2.4: LERF Contribution by initiating event.
- 2.3.2.5: LERF Contribution by accident class.

2.3.2.1 Consequence Bins: Source Term Severity

The radionuclide release categories are defined based on timing and severity. The severity of the radionuclide releases for purposes of binning sequences is characterized in terms of the radionuclide release fraction for CsI, which is a dominant contributor to both prompt and latent health effects. The CsI release fraction also correlates well with other contributors to offsite effects. For consequence calculations, additional radionuclides are included as inputs to the release. The bins used to define the release magnitude spectrum are as follows and each CET sequence endstate is assigned a release category.

Characterization	**Designator**	**CsI Release Fraction**
High	H	> 10%
Medium	M	> 1% and $\leq$ 10%
Low	L	> 0.1% and $\leq$ 1%
Low-Low	LL	$\leq$ 0.1%

2.3.2.2 Consequence Bins: Timing of Release

Each sequence that leads to a radioactive release from containment is classified as “early”, “intermediate”, or “late”. This designation is intended to reflect mitigation of consequences by evacuating people from the area, as appropriate. The “early” classification is used for scenarios in which a radioactive release occurs before the evacuation of the 10-mile Emergency Planning Zone (EPZ) is assumed to be complete. Based on the Evacuation Time Estimate (ETE) study (Exelon 2010), the worst-case conditions (weather, etc.) correlate to a 10-mile EPZ evacuation time of 4 hours from the point when a general emergency (GE) is declared. The “Early” scenarios, therefore, are those scenarios in which a radioactive release occurs within 4 hours of the time that a GE is declared. Releases occurring beyond 4 hours from the declaration of a GE are categorized as “late” (the “intermediate” classification is not used).

2.3.2.3 Level 2 Radionuclide Release Categories

The Level 2 containment event tree end states are delineated by the magnitude and timing of the calculated radionuclide release. Using the end state release magnitude and timing, a comparison can be developed to identify the overall frequency of the various end state release magnitudes (from very low (i.e., low-low) to high) and release timings (from early to late).

The frequency of radionuclide release is characterized by the quantification of the Level 1 and Level 2 PRA models. The Level 2 radioactive release frequency event tree end states are delineated by the magnitude and timing bins of the calculated radionuclide release (e.g., H/E corresponds to “high” magnitude and “early” timeframe).

Table 2.3.2-1 provides a frequency matrix of the radionuclide release categories and the Level 1 accident classes. Figure 2.3.2-1 presents the results as several bar charts.

A fraction (approximately 44%) of the core damage accidents transferred from Level 1 PRA are effectively mitigated, such that releases are essentially contained within an intact containment (i.e., INTACT release bin). In addition, only about 4% of the postulated accidents lead to “large early” release (i.e., approximately 4% of the accidents result in LERF).

2.3.2.4 FPIE LERF Contribution by Initiating Event

Table 2.3.2-2 summarizes the FPIE LERF contributors by initiating event. Figure 2.3.2-2 presents the results as a bar chart.

Loss of offsite power (LOOP) is the dominant initiating event as they represent a major loss of mitigating events that places a high importance on the emergency diesel generators. Additionally, the turbine trip initiating event is a large contributor to the FPIE LERF.

2.3.2.5 FPIE LERF Contribution by Accident Class

Table 2.3.2-3 summarizes the FPIE LERF contributors by accident class. Figure 2.3.2-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~51% of the LERF is attributed to Class IV, which involves failure of adequate shutdown reactivity (i.e., anticipated transients without scram, or ATWS sequences). The next highest contributor to LERF is Class IBE (~29%; station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe). All other accident classes contribute minimally to LERF when compared to Class IV and Class IBE.

2.3.3 System Importance Measures

The CPS PRA utilizes three industry standard risk importance measures to put the importance of components, trains, functions, initiating events (IE), Human Error Probabilities (HEPs), etc. into perspective:

- Fussell-Vesely (F-V) is the fractional contribution of the specific element in question (component, train, system, function, IE, or HEP) to the total risk. The F-V importance calculation is generally in the form of a fractional number that may be directly translated into a percentage contribution to risk. For example, 0.0230 or 2.3E-02 may be directly translated into a 2.3% contribution to risk.
- Risk Achievement Worth (RAW) is the factor by which the risk would increase if the specific element in question (component, train, system, function, IE, or HEP) is assumed to fail. For example, if a component, train, system, function or HEP has a RAW of 2.0, the calculated risk would double if the event were assumed to have a failure probability of 1.0.
- Risk Reduction Worth (RRW) is the factor by which the risk would decrease if the component, train, system, function, IE, or HEP is assumed to be perfectly reliable (i.e., if its probability of failure were zero).

Risk importance measures reflect the degree of contribution that a system or train's failure has to the current assessment of risk (Fussell-Vesely) or how greatly risk would be increased by the guaranteed failure of a train or system (RAW). These importance measures can be different for the different trains of a system or different among seemingly similar systems. Such asymmetries reflect the fact that system and train importance determinations for the CPS risk profile are affected by a number of factors. The three principal factors are:

- Plant design features that create higher importance for certain systems and trains.
- Masking of system or train importance by other failures.
- Modeling asymmetries (including pumps assumed normally operating).

Figure 2.3.3-1 shows the relative importance of system, train, or component importance to CPS FPIE CDF using the Fussell-Vesely importance measure.

Figure 2.3.3-2 shows the relative importance of system, train, or component importance to CPS FPIE LERF using the Fussell-Vesely importance measure.

2.3.4 Summary of the impact of asymmetries on risk

The principal plant design feature asymmetries impacting the CPS risk profile are:

- AC and DC Divisions 1, 2, and 3 support substantially different equipment.
- Reactor core isolation cooling (RCIC), RHR ‘A’ and low pressure core spray (LPCS) are on Division 1.
- RHR ‘B’ and RHR ‘C’ are on Division 2.
- Division 3 provides coolant injection (High Pressure Core Spray (HPCS) but does not provide a containment heat removal function.
- RHR ‘C’ is a low pressure coolant injection (LPCI)-only train (i.e., no suppression pool cooling or other decay heat removal capability). As such, RHR ‘C’ is less risk significant than RHR ‘A’ and RHR ‘B’ (which are capable of LPCI, SDC, suppression pool cooling and containment sprays).
- Containment venting paths modeled in the PRA will fail if Division 1 power is not available.
- SX Division 3 does not require room cooling for the 24 hour mission time, but SX Divisions 1 and 2 do require room cooling for the 24 hour mission time.
- Service water (WS) pumps A and C are powered by 4kV Balance of Plant (BOP) Bus 1A and WS pump B is powered by 4kV BOP Bus 1B.

2.4 FIRE MODEL OVERVIEW

2.4.1 Fire LEVEL 1 Results

The Fire CDF for the CL122AF0 Fire PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-11/yr. The CL122AF0 Level 1 Fire CDF is 3.12E-05/yr.

The CL122AF0 Level 1 model results are provided in the following subsections:

- 2.4.1.1: Fire CDF Contribution by physical analysis unit (PAU).
- 2.4.1.2: Fire CDF Contribution by fire scenario.
- 2.4.1.3: Fire CDF Contribution by accident class.

2.4.1.1 Fire CDF Contribution by PAU

Table 2.4.1-1 summarizes the Fire CDF contributors by PAU (i.e., fire zones). Figure 2.4.1-1 presents the results as a bar chart. Only PAUs with more than 1% contribution to the total Fire CDF are explicitly included in the table, otherwise, they are grouped together in the "Other" category.

2.4.1.2 Fire CDF Contribution by Scenario

Table 2.4.1-2 summarizes the Fire CDF contributors by fire scenario. Figure 2.4.1-2 presents the results as a bar chart. Only fire scenarios with more than 1% contribution to the total Fire CDF are explicitly included in the table, otherwise, they are grouped together in the "Other" category.

2.4.1.3 Fire CDF Contribution by Accident Class

Table 2.4.1-3 summarizes the Fire CDF contributors by accident class. Figure 2.4.1-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~55% of the Fire CDF is attributed to Class IIA, which involves a loss of containment heat removal with the RPV initially intact. This large contribution is due to a significant fraction of fires failing RHR suppression pool cooling (SPC) and containment venting. The next largest contributor is Class IBE (~20%; station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe). The significance of Class IBE is expected because Clinton's offsite power cables and bus duct run together in several areas of the plant.

2.4.2 Fire LEVEL 2 Results

The Fire LERF for the CL122AF0 Fire PRA model is calculated using the single-top model in CAFTA at a truncation of 5E-12/yr. The CL122AF0 Level 2 Fire LERF is 2.40E-06/yr.

The CL122AF0 Level 2 model results are provided in the following subsections:

- 2.4.1.1: Fire LERF Contribution by physical analysis unit (PAU).
- 2.4.1.2: Fire LERF Contribution by fire scenario.
- 2.4.1.3: Fire LERF Contribution by accident class.

2.4.2.1 Fire LERF Contribution by PAU

Table 2.4.2-1 summarizes the Fire LERF contributors by PAU (i.e., fire zones). Figure 2.4.2-1 presents the results as a bar chart. Only PAUs with more than 1% contribution to the total Fire LERF are explicitly included in the table, otherwise, they are grouped together in the "Other" category.

2.4.2.2 Fire LERF Contribution by Scenario

Table 2.4.2-1 summarizes the Fire LERF contributors by fire scenario. Figure 2.4.2-1 presents the results as a bar chart. Only fire scenarios with more than 1% contribution to the total Fire LERF are explicitly included in the table, otherwise, they are grouped together in the "Other" category.

2.4.2.3 Fire CDF Contribution by Accident Class

Table 2.4.2-3 summarizes the Fire LERF contributors by accident class. Figure 2.4.2-3 presents the results as a bar chart. These core damage accident class definitions are consistent with the NEI guidance in NEI 91-04 (NEI 1994).

From the results, ~39% OF Fire LERF is attributed to Class IA, which involves loss of inventory makeup in which the reactor pressure remains high. This high proportion emphasizes the high importance of depressurization. The other high contributors are Class IBE (~32%; station blackout with loss of coolant inventory makeup in the early (<4 hours) timeframe) and Class IIA (~23%; loss of containment heat removal with the RPV initially intact and core damage induced post-containment failure).

2.5 PRA QUALITY

The CPS PRA modeling is highly detailed, including a wide variety of initiating events, modeled systems, operator actions, and common cause events. The PRA model quantification process used for the CPS PRA is based on the event tree / fault tree methodology, which is a well-established methodology in the industry.

Constellation employs a multi-faceted approach to establishing and maintaining the technical adequacy and plant fidelity of the PRA models for all operating Constellation nuclear generation sites. This approach includes both a proceduralized PRA maintenance and update process, and the use of self-assessments and independent peer reviews. The following information describes this approach as it applies to the CPS PRA.

2.5.1 PRA Maintenance and Update

The Constellation Risk Management process ensures that the applicable PRA model remains an accurate reflection of the as-built and as-operated plants. This process is defined in the Risk Management program, which consists of a governing procedure (ER-AA-600, "Risk Management") and subordinate implementation guidelines. The overall Risk Management program defines the process for implementing regularly scheduled and interim PRA model updates, for tracking issues identified as potentially affecting the PRA models (e.g., due to changes in the plant, errors or limitations identified in the model, industry operating experience), and for controlling the model and associated computer files. To ensure that the current PRA model remains an accurate reflection of the as-built, as-operated plants, the following activities are routinely performed:

- Design changes and procedure changes are reviewed for their impact on the PRA model.
- New engineering calculations and revisions to existing calculations are reviewed for their impact on the PRA model.
- Maintenance unavailabilities are captured, and their impact on CDF is trended.
- Plant-specific initiating event frequencies, failure rates, and maintenance unavailabilities are updated approximately every four years.

In addition to these activities, the Risk Management procedures provide guidance for particular risk management and PRA quality and maintenance activities. This guidance includes:

- Documentation of the PRA model, PRA products, and bases documents.
- The approach for controlling electronic storage of Risk Management (RM) products, including PRA update information, PRA models, and PRA applications.
- Guidelines for updating the full-power, internal events PRA models for Constellation nuclear generation sites.
- Guidance for use of quantitative and qualitative risk models in support of the On-Line Work Control Process Program for risk evaluations for maintenance tasks (corrective maintenance, preventive maintenance, minor maintenance, surveillance tests and modifications) on systems, structures, and components (SSCs) within the scope of the Maintenance Rule (10 CFR 50.65(a)(4)).

In accordance with this guidance, regularly scheduled PRA model updates nominally occur on an approximately four-year cycle; shorter intervals may be required if plant changes, procedure enhancements, or model changes result in significant risk metric changes. In addition, Constellation now maintains a continuous updated model to ensure the risk assessment of the as-built, as-operated plant does not deviate significantly from the model of record.

2.5.2 Applicability of Peer Review Findings and Observations

The CPS PRA model for internal events received a formal industry peer review in October 2009. The CPS Full Power Internal Events (FPIE) (including internal flooding) Peer Review was performed using the NEI 05-04 process, the ASME/ANS PRA Standard (ASME/ANS RA-Sa-2009) and Regulatory Guide 1.200, Rev. 2. The Peer Review found that 78.5% of the SRs evaluated met Capability Category II or better. There were fifty-six (56) SRs that were assessed as "Not Met" and twelve (12) SRs that were assessed as meeting only Capability Category I. Of the 68 SRs which were assessed as not meeting Capability Category II or better, seven (7) were related to Internal Flooding SRs. Several of the F&Os associated with the open SRs were related to documentation issues.

The 2009 FPIE Peer Review F&Os were addressed during several periodic PRA updates and the resolutions to the F&Os were reviewed by independent review teams in two separate F&O Closures (in December 2018 and November 2019) that included FPIE & Fire PRA F&Os. The independent review teams concluded that for the FPIE PRA, one F&O was dispositioned as "partially resolved" and one F&O was dispositioned as "open". All other F&Os representing a gap to meeting CC II for all SRs were dispositioned as "resolved".

The FPIE PRA Peer Review identified FPIE F&Os associated with SRs assessed as less than CC II. Table 2.5-1 summarizes those F&Os that remain "open" (including those that may be only "partially resolved") at the time of this report. The F&Os discussed in this table represent the gaps to meeting Capability Category II for the FPIE PRA model.

As documented in Table 2.5-1, only two FPIE F&Os remain open. An assessment with respect to the impact on this application is also provided for each open F&O.

Based on the assessments provided in Table 2.5-1, it is concluded that the CPS Internal Events PRA (including internal flooding) is of adequate technical capability to support the SAMA analysis.

The CPS Fire PRA (FPRA) Peer Review was performed in April 2018 using the NEI 07-12 Fire PRA peer review process, the ASME/ANS PRA Standard (ASME/ANS RA-Sa-2009) and Regulatory Guide 1.200, Revision 2. The purpose of this review was to establish the technical adequacy of the FPRA for the spectrum of potential risk-informed plant licensing applications for which the FPRA may be used.

The 2018 CPS FPRA Peer Review was a full-scope review of the CPS at-power FPRA against all technical elements in Part 4 of the ASME/ANS PRA Standard, including the referenced internal events Supporting Requirements (SRs). The Peer Review found that 96.9% of the SRs evaluated met Capability Category (CC) II or better. There were five (5) SRs that were assessed as "Not Met" and eight (8) SRs that were assessed as meeting only CC I. Many of the F&Os, leading to open SRs, were related to documentation issues.

The 2018 FPRA Peer Review F&Os were addressed in subsequent FPRA updates and the resolutions to the F&Os were reviewed by independent review teams in two separate F&O Closures (in December 2018 and November 2019) that included FPIE & FPRA F&Os. The independent review teams concluded that for the FPRA, all F&Os have been dispositioned as "resolved".

In 2022, a Focused-Scope Peer Review (FSPR) was performed on Technical Element (TE) Fire Scenario Selection (FSS) due to the incorporation of updated fire modeling methodologies that classify as “PRA upgrade”. The FSPR found that 98% of the FSS SRs evaluated met CC II or better (one SR was assessed as “not applicable”). Two suggestion F&Os and one finding F&O were issued and all three F&Os were incorporated into the 2022 Fire PRA model prior to finalization.

As documented in Table 2.5-2, only one Fire PRA F&O remains open. An assessment with respect to the impact on this application is also provided for the open F&O.

Based on the assessment provided in Table 2.5-2, it is concluded that the CPS Fire PRA (including internal flooding) is of adequate technical capability to support the SAMA analysis.

2.5.3 PRA Quality Summary

The CPS PRA maintenance and update processes and technical capability evaluations described above provide a robust basis for concluding that the PRA is suitable for use in this risk-informed application.

3.0 LEVEL 3 RISK ANALYSIS

As discussed in Attachment F, the Level PRA 3 combines the Level 2 PRA results with site-specific parameters (e.g., population distribution, meteorological data, land use data, and economic data) to estimate offsite public dose and offsite economic consequences of the postulated releases to the environment. Section 3.0 addresses the key input parameters and analysis of the Level 3 portion of the risk assessment, and Section 7.3 summarizes a series of sensitivity evaluations to potentially impactful input parameters and modeling assumptions. The Level 3 results for the base case indicate that the total dose-risk is approximately 68.1 p-rem/yr. The total OECR is calculated to be about 963,000 $/yr.

The frequency of each release bin is shown in Table 3-1 including the frequencies from full power internal events (FPIE) which include contributions from internal flooding, and the fire frequencies.

Following the completion of the Level 3 model, two other documents finalized in 2022 were recognized to have potential impact on the Level 3 modeling and results. These two documents are evaluated in Section 7.3 of this addendum.

4.0 BASELINE RISK MONETIZATION

This section explains how CPS calculated the monetary value of the status quo (i.e., accident consequences assuming no mitigation due to SAMA implementation). CPS also used this analysis to establish the maximum benefit that could be achieved if all on-line CPS risk were eliminated, which is referred to as the Maximum Averted Cost-Risk (MACR). Per the site PRA models (designated CL122A and CL122AF0), the internal events (including internal flooding) CDF is 2.00E-06/yr (at a truncation of 1E-12/yr) and the Fire CDF is 3.12E-05/yr (at a truncation of 5E-11/yr). The total FPIE and Fire CDF used to develop the MACR is, therefore, 3.32E-5/yr (2.00E-06/yr + 3.12E-05/yr = 3.32E-05/yr). Non-Fire external risk is addressed in Section 4.1.2.

4.1 MAXIMUM AVERTED COST-RISK

The CPS MACR is the total averted cost-risk if all internal and external events risks associated with on-line operation were eliminated. This is calculated by summing the following components:

- Maximum Internal Events and Fire Averted Cost-Risk
- Maximum Non-Fire External Events Averted Cost-Risk

The MACR is used in the Phase I analysis as a means of screening SAMAs. The following subsections provide a description of how each of these components is calculated and used together to obtain the CPS MACR.

4.1.1 Internal Events and Fire Maximum Averted Cost-Risk

The maximum internal events and Fire averted cost-risk is the sum of the contributors calculated using the approaches documented in Sections F.4.1 through F.4.5:

Maximum Averted Internal Events and Fire Cost-Risk

Off-site exposure cost	$2,740,819
Off-site economic cost	$6,082,064
On-site exposure cost	$68,845
On-site cleanup cost	$647,067
Replacement power cost	$214,088
Total cost (per unit)	$9,752,833

This total represents the per unit monetary equivalent of the risk that could be eliminated if all risk associated with on-line internal event hazards (including internal floods) could be eliminated for CPS. The internal events MACR is rounded to next highest thousand ($9,753,000) for SAMA calculations. It should be noted that the Phase II cost benefit calculations account for the difference between the rounded MACR and the actual MACR by adding the difference to the cost-risk calculated for each SAMA configuration.

4.1.2 Non-Fire External Events Maximum Averted Cost-Risk

The maximum averted cost-risk for external events excluding Fire must be considered for the cost-benefit calculations; however, the current CPS External Hazards Assessment (Exelon 2020) applied a progressive screening approach and of the hazards considered, only seismic events required the development of a core damage frequency.

The method chosen to account for external events contributions in the SAMA analysis is to use a multiplier on the internal events results. In previous NRC-approved SAMA analyses, it has been assumed that the risk posed by external events and internal events is approximately equal. This assumption is not unreasonable unless analyses are available that provide more detailed insights into the potential contributions of these types of events. Because internal Fires and Seismic events are typically the most significant contributors and because the Fire PRA results are used directly in the CPS SAMA analysis, it was concluded that the development of a plant-specific non-fire external events multiplier was warranted.

The non-fire external events multiplier is the ratio of the total CDF (including internal and external events) to only the FPIE and Fire CDFs. The lack of detailed analyses makes it difficult to establish a meaningful CDF for some event types; however, the following assumptions were used to simplify the process:

- Hazards that were screened from consideration for the RICT and 10 CFR 50.69 applications were considered to be negligible and were not included in the calculation of the non-fire external events multiplier.
- For those hazards that were not screened as negligible, the CDFs were considered to be non-negligible and were included in the calculation of the non-fire external events multiplier.

The seismic CDF that was developed in the CPS External Hazards Assessment was 6.4E-6/yr while all other hazards were screened. The screened hazards are as follows: aircraft impact, avalanche, biological event, coastal erosion, drought, external flooding, extreme wind or tornado (including tornado missiles), fog, forest or range fire, frost, hail, high summer temperature, high tide/lake level/river stage, hurricane, ice cover, industrial or military facility accident, landslide, lightning, low lake level or river stage, low winter temperature, meteorite or satellite, pipeline accident, release of chemicals in onsite storage, river diversion, sand or dust storm, seiche, snow, solid shrink-swell consolidation, storm surge, toxic gas, transportation accident, tsunami, turbine-generated missiles, volcanic activity, and waves.

Using the CDF values described above, the non-fire external events (EE) contributions could be summarized as follows:

CPS External Events CDF Summary (per year)	
Seismic	6.40E-06
Other	negligible
Total EE CDF	**6.40E-06**

The non-fire External Events multiplier is the ratio of the total CDF (including internal and external events) to the sum of the internal events and fire CDFs. Using the total external events of 6.40E-06 from above, the internal events CDF of 2.00E-06, the fire CDF of 3.12E-05, the non-fire External Events multiplier is:

Non-Fire EE Multiplier = (6.40E-06 + 2.00E-06 + 3.21E-05) / 3.96E-05 = 1.193

4.1.3 CPS Maximum Averted Cost-Risk

The total MACR can be obtained by multiplying the internal events cost-risk by the non-fire EE multiplier of 1.193:

Single Unit MACR = $9,753,000 * 1.193 = $11,635,329

Alternatively, as stated in Section F.4.6, the MACR can be represented by the internal and external events contributions:

Internal Events and Fire	=	$9,753,000
Non-fire External Events	=	$1,882,239
CPS Maximum Averted Cost-Risk	=	$11,635,329

5.0 PHASE 1 SAMA ANALYSIS

The Phase 1 SAMA analysis has been re-performed using the CL122A and CL122AF0 models. The portions of the SAMA identification process that are not directly related to the CPS PRA model importance list reviews were not changed from the baseline analysis and documentation of those reviews have not been included in this addendum (e.g., the review of other industry SAMAs). However, those SAMAs that were developed based on a review of those other sources have been retained for evaluation.

In order to facilitate comparisons between the CL117B/CL117BF0 and CL122A/CL122F0 SAMA identification tasks, the SAMA numbers from the CL117B/CL117BF0 process were retained and those SAMAs that were not identified through review of the CL122A/CL122F0 importance list review were marked as “Not Used” in Table 5-3. The “new” SAMAs, that is, those identified using the CL122A/CL122F0 results that were not identified using the CL117B/CL117BF0 model results, were assigned SAMA numbers beginning with SAMA number 23.

5.1 SAMA IDENTIFICATION

The following is a summary of the importance list review tables resulting from the CL122A/CL122F0 importance list reviews:

- Table 5-1a: FPIE Level 1 importance list review
- Table 5-1b: Fire Level 1 importance list review
- Table 5-2a: FPIE Level 2 HE/HL importance list review
- Table 5-2b: FPIE Level 2 ME/ML importance list review
- Table 5-2c: FPIE Level 2 HE BOC importance list review
- Table 5-2d: FIRE Level 2 HE/HL importance list review
- Table 5-2e: FIRE Level 2 ME/ML importance list review

5.2 PHASE 1 SCREENING PROCESS

The initial list of SAMA candidates (Phase 1 SAMAs) is presented in Table 5-3 along with the conclusion of the Phase 1 screening process for each SAMA.

Those SAMAs that could not be screened required a more detailed cost-benefit analysis and were passed to the Phase 2 analysis. The Phase 2 screening process is described in Section 6.

6.0 PHASE 2 SAMA ANALYSIS

The SAMA candidates identified as part of the Phase 2 analysis are listed in Table 6-1 in conjunction with the conclusion of the Phase 2 screening process for each SAMA.

The following sections describe the cost-benefit analysis that was used for each of the Phase 2 SAMA candidates.

The following SAMAs were identified as no longer relevant / required using the CL122A model and are therefore not discussed in subsequent sections:

- SAMA 1: Provide Portable HVAC Equipment and Supporting Procedures for Alternate DG Room Cooling
- SAMA 13: Alternate ECCS Pump Room Cooling
- SAMA 16: Squib Valve Bypass Line

6.1 SAMA 2: PROCEDURALIZE DC CURRENT CHECK FOR ELAP LOAD SHED ACTION

Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.

The modeling of the DC load shed action in the PRA includes some conservative assumptions related to the failure mode of the action and the action’s timing requirements – specifically, failure to shed any load within the time assumed in the battery life calculations results in failure of the action even if the load is small would not necessarily preclude success. Similarly, if a breaker is opened shortly after the assumed time limit for the action, the action is still assumed to be failed. While these assumptions may oversimplify and overestimate the probability of failure of the load shed action, the model highlights the action’s importance and including a verification that the action has been completed successfully is considered to be a good practice approach to managing plant risk.

Assumptions:

The HEP for the action has been revised by updating the recovery step to represent a procedure-based check and if the current is identified as being out of range, it is assumed that the breaker omission(s) will be recovered. Because the current check would be performed by a different person, in a different location, and using instruments that are separate from the controls manipulated to complete the action, zero dependence is assumed to exist between manipulation errors and the current check step.

PRA Model Changes to Model SAMA:

The HEP was reduced from 6.3E-01 to 3.8E-02 (FPIE) and 3.0E-01 (Fire) based on the inclusion of the procedure step to confirm that battery current is within the correct range.

- Updated independent HEPs.
- Updated relevant dependent action combinations (Joint HEPs).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.92E-06	2.98E-05	3.17E-05	26.47	$394,601
Percent Reduction	4.0%	4.6%	4.6%	2.7%	2.4%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.23E-08	7.29E-07	7.81E-07	1.27E+00	$20,237
ST3 - H/L	3.12E-07	1.22E-05	1.25E-05	2.04E+01	$324,808
ST4 - M/E	1.44E-07	3.80E-06	3.95E-06	3.25E+00	$41,051
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,126
ST6 - L/E	8.16E-08	2.82E-06	2.90E-06	4.32E-01	$1,984
ST7 - L/L	1.40E-07	4.01E-07	5.41E-07	4.14E-02	$158
ST8 - LL/E	4.54E-09	1.62E-07	1.66E-07	1.26E-02	$42
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.01E-06	5.64E-06	6.66E-06	1.15E-02	$93
Total	**9.06E-07**	**2.41E-05**	**2.50E-05**	**2.65E+01**	**$394,601**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of \$9,489,366. After accounting for "round up" of the base internal events and fire cost-risk, this value is \$9,489,483. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$9,489,483 * 1.193 = \$11,320,953$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 2 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,320,953	$314,376

Based on a \$50,000 cost of implementation for CPS, the net value for this SAMA is \$264,376 (\$314,376 - \$50,000), which indicates this SAMA is potentially cost-beneficial.

6.2 SAMA 3: PROTECT THE RCIC STORAGE TANK AND PROVIDE LONG TERM MAKEUP

While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.

Assumptions:

If the RCIC storage tank is protected, it provides an additional means of providing makeup, and if containment venting is used with it, and alternate means of containment heat removal. If the current FLEX strategy fails, RCIC may be used taking suction from the RCIC storage tank and Containment Vent path #6 (unscrubbed) is assumed to be made available by powering the busses the support valve operation with the FLEX generators.

The existing containment venting action using vent path #6 is adequate for modeling the venting action for this SAMA.

The FLEX generator can support the containment vent valve load or loads will be shed by procedure to support vent valve operation, when required.

The RCIC storage tank has adequate inventory for the mission time.

DC load shed is still required for success as it will provide power to the batteries to maintain RCIC control/instrumentation until the FLEX generator is aligned.

PRA Model Changes to Model SAMA:

In order to approximate the impact of a having RCIC as the injection source from the RCIC storage tank with the containment vent providing heat removal, the current FLEX gate logic has been ANDed with new, simplified logic that captures the major events/support systems required for operations.

Model Change(s):

The following changes were made to the fault tree:

- Gate RCIC-RHRA-FLEX: Added a new AND gate (RCIC-RHRA-FLEX-1) above gate RCIC-FLEX-RHRA-PATH. Gate UGATE23L added under this new AND gate.
- Gate RCIC-RHRB-FLEX: Added a new AND gate (RCIC-RHRB-FLEX-1) above gate RCIC-FLEX-RHRB-PATH. Gate UGATE23L added under this new AND gate.
- Gate RCICT-FLEX-SBO: Added new AND gate SAMA-03-BOTH and deleted gate RCICT-FLEX.
- New AND gate SAMA-03-BOTH: includes existing gate RCICT-FLEX and new gate OR SAMA-3-RCIC-VT.
- New OR gate SAMA-3-RCIC-VT: Includes existing gates RCICL, U2-LT-FLEX, and HFE-057, and new OR gate SAMA-3-VENT.
- New OR gate SAMA-3-VENT: Includes existing gates OP-INIT-VENT and FGATE-TT3, and new OR gate SAMA-3-VENT-1.
- New OR gate SAMA-3-VENT-1: includes existing gates/events HFE-022 and 1VRFL-1VR05M-P-- and new OR gate SAMA-3-VENT-2.
- New OR gate SAMA-3-VENT-2: includes existing event 1VRDM-1VR04Y-D-- and new OR gates SAMA-3-VENT-VLV6A and SAMA-3-VENT-VLV6B.
- New OR gate SAMA-3-VENT-VLV6A: includes existing event 1VRAV-1VR006AD-- and new OR gate SAMA-VENT-VLV6A-1.

- New OR gate SAMA-3-VENT-VLV6B: includes existing events 1VRAV-1VR006BD-- and 1CVPH-TEMPF--F-- and new OR gate SAMA-VENT-VLV6B-1.
- New OR gate SAMA-VENT-VLV6A-1: Includes existing gates/events 1IAAV-IA005--D--, 1IAAV-IA006--D--, and FLEX-PWR-BUS1F.
- New OR gate SAMA-VENT-VLV6B-1: Includes existing gates/events 1IAAV-IA005--D--, 1IAAV-IA006--D--, and FLEX-PWR-BUS1G.
- Gate RCICT-FLEX-RSDP: Added new AND gate RCIC-FLEX-RSDP-SAMA-3. Deleted gate RCIC-FLEX-RSDP.
- New AND gate RCIC-FLEX-RSDP-SAMA-3: Includes existing gate RCIC-FLEX-RSDP and new OR gate RCIC-FLEX-RSDP-SAMA-3-1.
- New OR gate RCIC-FLEX-RSDP-SAMA-3-1: Includes existing gates HFE-093, U2-LT-FLEX, HFE-057, and RCICL, plus new OR gate SAMA-3-VENT (described above).

The following changes were made to the Flag File:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

The following changes were made to the cutsets:

- Based on a detailed review of Fire combo FDEPGROUP-COMB013, the event order in the assessment HRA been changed to place the breaker operation first followed by the load shed action since SBO does not occur until after failure of the breaker manipulation leads to loss of AC power. High dependence between the actions is retained and the revised Joint Human Error Probability (JHEP) is 2.7E-2 (down from 3.9E-2).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.82E-06	3.10E-05	3.29E-05	26.44	$391,678
Percent Reduction	9.2%	0.5%	1.0%	2.8%	3.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.84E-08	8.14E-07	8.72E-07	1.42E+00	$22,596
ST3 - H/L	1.59E-07	1.20E-05	1.21E-05	1.97E+01	$313,740
ST4 - M/E	1.52E-07	4.30E-06	4.45E-06	3.67E+00	$46,322
ST5 - M/L	1.28E-07	3.45E-06	3.58E-06	9.73E-01	$6,117
ST6 - L/E	2.89E-07	3.43E-06	3.72E-06	5.54E-01	$2,545
ST7 - L/L	9.90E-08	3.39E-07	4.38E-07	3.34E-02	$128
ST8 - LL/E	9.23E-09	1.24E-07	1.34E-07	1.01E-02	$34
ST9 - LL/L	3.86E-08	5.02E-07	5.40E-07	2.57E-02	$78
ST10 - INTACT	8.83E-07	6.13E-06	7.01E-06	1.21E-02	$97
Total	**9.33E-07**	**2.49E-05**	**2.58E-05**	**2.64E+01**	**$391,678**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,475,422. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,475,539. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,475,539 * 1.193 = \$11,304,318$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 3 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,304,318	$331,011

Based on a $8,915,554 cost of implementation for CPS, the net value for this SAMA is --$8,584,543 ($331,011 - $8,915,554), which indicates this SAMA is not cost-beneficial.

6.3 SAMA 4: ENHANCE CONTAINMENT VENTING CAPABILITY (E.G., FLEX HARDPIPE VENT)

This SAMA was screened during Phase 1 (i.e., implementation cost is greater than MACR). See Table 5-3 for details.

6.4 SAMA 5: INSTALL AN EMERGENCY TIE LINE FROM THE SWITCHYARD TO AN EMERGENCY BUS

The process to restore offsite AC power (OSP) to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.

Assumptions:

It is assumed that this SAMA reduces the execution time for the bus realignment action from 60 minutes to 30 minutes, which will provide for more recovery time to the operators. Based on a review of the evaluation of the existing action in the HRAC, the reduction in execution time in combination with the consideration of potential recovery steps resulted in a reduction of the HEP from 6.2E-02 to 1.5E-02.

PRA Model Changes to Model SAMA:

The addition of the emergency tie line has been modeled by reducing the HEP associated with the alignment action.

Model Change(s):

The following modeling changes were made:

- 1APOP-OSP-RX-H-- (OPERATOR FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RECOVERY OF OSP): Basic event probability changed from 6.2E-02 to 1.2E-02.
- Relevant JHEP values were updated with revised HEP.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.90E-06	3.10E-05	3.29E-05	26.95	$400,753
Percent Reduction	5.2%	0.6%	0.8%	0.9%	0.9%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.73E-08	8.03E-07	8.60E-07	1.40E+00	$22,283
ST3 - H/L	2.87E-07	1.22E-05	1.25E-05	2.04E+01	$324,206
ST4 - M/E	1.51E-07	4.23E-06	4.38E-06	3.61E+00	$45,589
ST5 - M/L	1.24E-07	3.43E-06	3.56E-06	9.67E-01	$6,080
ST6 - L/E	1.23E-07	3.09E-06	3.21E-06	4.79E-01	$2,198
ST7 - L/L	1.32E-07	3.95E-07	5.28E-07	4.03E-02	$154
ST8 - LL/E	9.13E-09	1.64E-07	1.73E-07	1.31E-02	$44
ST9 - LL/L	4.10E-08	5.15E-07	5.56E-07	2.65E-02	$81
ST10 - INTACT	9.72E-07	6.16E-06	7.13E-06	1.23E-02	$99
Total	**9.24E-07**	**2.49E-05**	**2.58E-05**	**2.70E+01**	**$400,753**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,664,928. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,665,045. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,665,045 * 1.193 = \$11,530,399$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 5 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,530,399	$104,930

Based on a $400,000 cost of implementation for CPS, the net value for this SAMA is -$295,070 ($104,930 - $400,000), which indicates this SAMA is not cost-beneficial.

6.5 SAMA 6: PROVIDE FLOOD PROTECTION FOR MCR HVAC DUCTS

A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.

Assumptions:

Performing improvements on the HVAC ductwork will reduce the probability that water will penetrate into the MCR and lead to abandonment, but it will not necessarily be a "perfect" fix. The frequency of a significant flooding event into the MCR is assumed to be reduced by a factor of 5.

PRA Model Changes to Model SAMA:

The impact of the improved HVAC ductwork is represented in the PRA by reducing the probability of a failure to safely shut the plant down when a flood occurs by factor of 5.

Note: Different failure probabilities could be proposed/supported for the flood protection strategy proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following change was made to the cutset files:

- 1MCR-ABANDON (FLOOD (MAJOR) IN CB-1I CAUSES ABANDONMENT IN MCR): Probability changed from 5E-02 to 1E-02.
- No impact on the fire model (the event is for mitigating internal flooding events).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
SAMA Value	1.51E-06	3.12E-05	3.27E-05	27.19	$404,165
Percent Reduction	24.6%	-0.1%	1.4%	0.0%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.71E-08	8.15E-07	8.72E-07	1.42E+00	$22,587
ST3 - H/L	3.09E-07	1.23E-05	1.26E-05	2.05E+01	$326,454
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,407
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,126
ST6 - L/E	1.30E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.14E-07	4.02E-07	5.16E-07	3.94E-02	$151
ST8 - LL/E	9.53E-09	1.64E-07	1.73E-07	1.31E-02	$44
ST9 - LL/L	2.63E-08	5.23E-07	5.49E-07	2.61E-02	$80
ST10 - INTACT	5.79E-07	6.16E-06	6.74E-06	1.17E-02	$94
Total	**9.28E-07**	**2.51E-05**	**2.60E-05**	**2.72E+01**	**$404,165**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,734,938. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,735,055. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,735,055 * 1.193 = \$11,613,921$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 6 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,613,921	$21,408

Based on a $475,000 cost of implementation for CPS, the net value for this SAMA is -$453,592 ($21,408 - $475,000), which indicates this SAMA is not cost-beneficial.

6.6 SAMA 7: ENHANCE PROCEDURES AND OPERATOR TRAINING TO INCLUDE CONTAINMENT VENTING CONTROL FOR NPSH MANAGEMENT

For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose net positive suction head (NPSH) and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.

Assumptions:

The procedure improvements and additional training on management of NPSH during containment venting will result in an action reliability that is comparable to RPV level control during an ATWS event with Feedwater available. The HEP for that action is 3.5E-2 and the HEP for NPSH management during containment venting is assumed to be 5.0E-02 (reduced by an order of magnitude from 5.0E-01).

The probabilities of the dependent action combinations including this HFE are governed mostly by the level of dependence for this late term action and no changes are necessary to the JHEPs.

Note: Different failure probabilities could be proposed/supported for the controlled venting action proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

PRA Model Changes to Model SAMA:

The HEP for the existing action to control containment venting was reduced in the cutsets to reflect the revised procedures and training.

Model Change(s):

The following change was made to the cutset files:

- 1CVOPVENTCTRLH-- (OP FAILS TO CONTROL CONTAINMENT VENT) HEP changed from 5.0E-01 to 5.0E-02.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.97E-06	3.09E-05	3.28E-05	26.93	$400,614
Percent Reduction	1.4%	1.1%	1.1%	1.0%	0.9%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.86E-08	8.11E-07	8.70E-07	1.42E+00	$22,523
ST3 - H/L	3.16E-07	1.22E-05	1.25E-05	2.03E+01	$323,338
ST4 - M/E	1.51E-07	4.31E-06	4.46E-06	3.67E+00	$46,375
ST5 - M/L	1.08E-07	3.27E-06	3.38E-06	9.18E-01	$5,772
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.40E-07	4.02E-07	5.41E-07	4.14E-02	$158
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.02E-06	6.12E-06	7.14E-06	1.23E-02	$99
Total	**9.56E-07**	**2.47E-05**	**2.57E-05**	**2.69E+01**	**$400,614**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,658,196. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,658,313. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,658,313 * 1.193 = \$11,522,367$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 7 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,522,367	$112,962

Based on a $250,000 cost of implementation for CPS, the net value for this SAMA is -$137,038 ($112,962 - $250,000), which indicates this SAMA is not cost-beneficial.

6.7 SAMA 8: REPLACE THE INBOARD CONTAINMENT VENT AOV WITH AN ENVIRONMENTALLY QUALIFIED VALVE

A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.

Assumptions:

Installation of a re-designed valve will reduce the failure rate of the valve by an order of magnitude.

PRA Model Changes to Model SAMA:

The event representing the failure of the valve to operate due to adverse environmental conditions has been reduced by an order of magnitude.

Note: Different failure probabilities could be proposed/supported for the redesigned containment vent valve proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made to the cutsets:

- 1CVPH-TEMPF--F-- (IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1): Probability changed from 1.0E-02 to 1.0E-03.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.92E-06	3.08E-05	3.27E-05	26.91	$400,246
Percent Reduction	4.2%	1.3%	1.5%	1.1%	1.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.81E-08	8.14E-07	8.72E-07	1.42E+00	$22,589
ST3 - H/L	2.97E-07	1.22E-05	1.25E-05	2.03E+01	$322,878
ST4 - M/E	1.51E-07	4.31E-06	4.46E-06	3.67E+00	$46,374
ST5 - M/L	8.79E-08	3.30E-06	3.39E-06	9.23E-01	$5,801
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.40E-07	4.02E-07	5.41E-07	4.14E-02	$158
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.00E-06	6.02E-06	7.02E-06	1.21E-02	$98
Total	**9.17E-07**	**2.48E-05**	**2.57E-05**	**2.69E+01**	**$400,246**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,647,477. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,647,594. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,647,594 * 1.193 = \$11,509,580$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 8 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,509,580	$125,749

Based on a $1,828,302 cost of implementation for CPS, the net value for this SAMA is -$1,702,553 ($125,749 - $1,828,302), which indicates this SAMA is not cost-beneficial.

6.8 SAMA 9: INSTALL KEYLOCK SWITCH TO OVERRIDE MSIV LOW RPV LEVEL ISOLATION LOGIC

For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level main steam isolation valve (MSIV) isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly. Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.

Assumptions:

The HEP for action 1MSOP-LLINTLKH–(CREW FAILS TO BYPASS MSIV CLOSURE LOW LEVEL INTLK) is reduced from 5.7E-1 to 3.5E-02 by modifying the HFE as follows:

- Reduced execution time (Texe) to 1 minute based on simplified keylock switch
- Updated execution steps to reflect switch manipulation rather than installation of jumpers.
- Included generic self-recovery failure probability of 0.1 to each execution step.
- Used the lower bound ASEP time reliability curve to reflect a simple, well understood, and well-trained action.

PRA Model Changes to Model SAMA:

To approximate the impact of this SAMA, the action's HEP was updated to 3.5E-02 and the joint HEPs that include the action were updated with the revised HEP.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.96E-06	3.12E-05	3.32E-05	27.17	$403,891
Percent Reduction	2.1%	0.0%	0.1%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 – H/E	5.12E-08	8.14E-07	8.65E-07	1.41E+00	$22,408
ST3 – H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,661
ST4 – M/E	1.24E-07	4.31E-06	4.43E-06	3.65E+00	$46,088
ST5 – M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,126
ST6 – L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 – L/L	1.40E-07	4.02E-07	5.41E-07	4.14E-02	$158
ST8 – LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 – LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 – INTACT	1.01E-06	6.16E-06	7.18E-06	1.24E-02	$100
Total	**9.44E-07**	**2.50E-05**	**2.60E-05**	**2.72E+01**	**$403,891**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,741,265. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,741,382. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,741,382 * 1.193 = \$11,621,469$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 9 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,621,469	$13,860

Based on a $635,242 cost of implementation for CPS, the net value for this SAMA is -$621,382 ($13,860 - $635,242), which indicates this SAMA is not cost-beneficial.

6.9 SAMA 10: INSTALL A HARD PIPED CONNECTION TO ALLOW RAPID ALIGNMENT OF FPS FOR RPV MAKEUP

Currently, the Fire Protection System (FPS) can be used to inject to the RPV, but it requires significant manual work to remove the internals of a check valve and time to perform the alignment. The availability of a hard piped, direct connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations. Ensuring it is diverse from the existing service water cross-tie and/or ensuring it can be aligned without support systems would maximize benefit.

Assumptions:

While changes to the physical design of the FPS connection will simplify the alignment steps and reduce the time required to perform the action to align FPS for RPV injection, the action will often occur in combination with other operator actions, many of which will be related to RPV inventory control, which likely implies at least a high level of dependence. In addition, the lower quality of water from the FPS and its status would preclude it from being a preferred system such that the alignment would only be directed after the preferred systems are determined to be unavailable. Therefore, while the alignment/execution time would be reduced by this SAMA, the later start to the alignment process relative to “preferred” systems may still lead to timing conditions that would preclude the independent HEP from being low. To address these factors, the failure probability of the event applied to the cutsets will be 0.5.

PRA Model Changes to Model SAMA:

The flag event that represents failure to align the FPS for injection that is currently in the model and set to TRUE has been set to have a failure probability of 0.5.

Note: Different failure probabilities could be proposed/supported for the action to align fire protection for RPV makeup that is proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made to the model:

- FPIE: 1FPOPALIGN-FPH–(OPERATOR FAILS TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION PER CPS 4411.03): Probability set to 0.5 in the database.

- FIRE: 1FPOPALIGN-FPH-F: (OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION – FIRE PRA VERSION): Probability set to 0.5 in the database.
- Removed both events from FPIE flag file (were set to TRUE).
- In the FPIE recovery file, set the probability to 0.5 (was previously set to 1.0 in the recovery file).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.89E-06	2.87E-05	3.06E-05	26.17	$389,630
Percent Reduction	5.4%	8.0%	7.9%	3.8%	3.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	2.44E-10	0.00E+00	2.44E-10	1.28E-03	$11
ST2 – H/E	5.76E-08	7.00E-07	7.58E-07	1.23E+00	$19,622
ST3 – H/L	3.06E-07	1.19E-05	1.22E-05	1.99E+01	$316,135
ST4 – M/E	1.51E-07	4.29E-06	4.44E-06	3.65E+00	$46,186
ST5 – M/L	1.09E-07	2.90E-06	3.01E-06	8.18E-01	$5,145
ST6 – L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,202
ST7 – L/L	1.32E-07	3.36E-07	4.68E-07	3.58E-02	$137
ST8 – LL/E	9.70E-09	1.55E-07	1.65E-07	1.25E-02	$42
ST9 – LL/L	3.64E-08	4.31E-07	4.67E-07	2.22E-02	$68
ST10 – INTACT	9.60E-07	4.90E-06	5.86E-06	1.01E-02	$81
Total	**9.33E-07**	**2.38E-05**	**2.47E-05**	**2.62E+01**	**$389,630**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,353,888. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,354,005. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,354,005 * 1.193 = \$11,159,328$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 10 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,159,328	$476,001

Based on a $649,194 cost of implementation for CPS, the net value for this SAMA is -$173,193 ($476,001 - $649,194), which indicates this SAMA is not cost-beneficial.

6.10 SAMA 11: REPLACE VALVES WITH VERSIONS DESIGNED TO CLOSE AGAINST HIGH FLOW AND DIFFERENTIAL PRESSURE

The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.

Assumptions:

The probability that the new valve will fail to close during an ISLOCA incident is 1E-2. The "new valve" is actually a set of valves that are capable of mitigating each of the ISLOCA sequences in the FPIE model.

There is no impact on the Fire model.

The cost of implementation is a lower bound cost for the CPS SAMA. The implementation cost is based on the installation of two valves; however, in order to achieve the risk reduction resulting from the changes made to model this SAMA, several additional valve replacements would be required. The low averted cost-risk related to this SAMA does not require further refinement of the implementation cost.

PRA Model Changes to Model SAMA:

To represent the impact of the new isolation valves, the ISLOCA sequence tags have been changed from TRUE events to events with a probability of 1.0E-02.

Model Change(s):

The following changes were made to the cutsets:

- RCVSEQ-ISLOCA-002 (ACCIDENT SEQUENCE ISLOCA-002): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-004 (ACCIDENT SEQUENCE ISLOCA-004): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-005 (ACCIDENT SEQUENCE ISLOCA-005): Event probability changed to 1.0E-02.
- RCVSEQ-ISLOCA-006 (ACCIDENT SEQUENCE ISLOCA-006): Event probability changed to 1.0E-02.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,389
Percent Reduction	0.2%	-0.1%	0.0%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	4.08E-10	0.00E+00	4.08E-10	2.15E-03	$19
ST2 – H/E	5.86E-08	8.15E-07	8.74E-07	1.42E+00	$22,626
ST3 – H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,625
ST4 – M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,406
ST5 – M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,126
ST6 – L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 – L/L	1.40E-07	4.02E-07	5.42E-07	4.14E-02	$158
ST8 – LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 – LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 – INTACT	1.02E-06	6.16E-06	7.18E-06	1.24E-02	$100
Total	**9.79E-07**	**2.51E-05**	**2.60E-05**	**2.72E+01**	**$404,389**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of \$9,753,027. After accounting for "round up" of the base internal events and fire cost-risk, this value is \$9,753,144. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$9,753,144 * 1.193 = \$11,635,501$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 11 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
\$11,635,329	\$11,635,501	(\$172)

Based on a \$600,000 cost of implementation for CPS, the net value for this SAMA is -\$600,172 (-\$172 - \$600,000), which indicates this SAMA is not cost-beneficial.

6.11 SAMA 12: MODIFY PLANT PROCEDURES TO DIRECT USE OF FLEX GENERATORS TO SUPPORT CONTAINMENT VENTING

The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed at supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power (i.e., the do not isolate when the isolation conditions exist). A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.

Assumptions:

Current FLEX modeling related to repowering the 480V MCCs is applicable to providing power to the buses that support containment venting.

PRA Model Changes to Model SAMA:

To represent the impact of the new isolation valves, the fault tree was changed such that the containment vent paths only fail in SBO scenarios when the alignment of FLEX power to the 480V buses fails.

Model Change(s):

The following changes were made to the fault tree:

- Gate G005: Created a new AND gate above A1AP77EX (gate SAMA-12-1B3) to represent failure of normal and FLEX power to the MCC. Under the AND gate is a new gate (SAMA-12-1B3-FLEX) which includes power from the FLEX DGs, relevant FLEX HFEs, and entry conditions (i.e., SBO required, successful DC load shed, and RCIC short-term).
- Gate Q1FC008: Similar changes as gate G005.
- Gate QGATE113: Similar changes as gate G005.
- Gate QGATE14: Similar changes as gate G005.
- Gate QGATE08: Similar changes as gate G005.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	**Fire CDF**	**CDF (Total)**	**Dose-Risk (Total)**	**OECR (Total)**
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.96E-06	3.11E-05	3.30E-05	26.99	$400,940
Percent Reduction	2.0%	0.4%	0.5%	0.8%	0.9%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	**FPIE Freq.$_{SAMA}$**	**Fire Freq.$_{SAMA}$**	**Total Freq.$_{SAMA}$**	**Dose-Risk$_{SAMA}$**	**OECR$_{SAMA}$**
ST1 – BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 – H/E	5.81E-08	8.13E-07	8.71E-07	1.42E+00	$22,562
ST3 – H/L	2.86E-07	1.22E-05	1.25E-05	2.03E+01	$323,248
ST4 – M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,398
ST5 – M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,125
ST6 – L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 – L/L	1.40E-07	4.01E-07	5.41E-07	4.13E-02	$158
ST8 – LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 – LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 – INTACT	1.01E-06	6.12E-06	7.14E-06	1.23E-02	$99
Total	**9.47E-07**	**2.49E-05**	**2.59E-05**	**2.70E+01**	**$400,940**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,674,919. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,675,036. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$9{,}675{,}036 * 1.193 = \$11{,}542{,}318$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 12 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,542,318	$93,011

Based on a $100,000 cost of implementation for CPS, the net value for this SAMA is -$6,989 ($93,011 - $100,000), which indicates this SAMA is not cost-beneficial.

6.12 SAMA 14: INSTALL 3-HOUR RATED FIRE CABLE WRAP ON OFFSITE POWER CABLES IN RISK-SIGNIFICANT AREAS

Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the Reserve Auxiliary Transformer (RAT)/Emergency Reserve Auxiliary Transformer (ERAT) feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.

Assumptions:

This SAMA has no significant impact on the FPIE model.

The cable wrap prevents failure of protected cables 100% of the time.

PRA Model Changes to Model SAMA:

The potential for fires on cables related to the RAT/ERAT distribution.

Model Change(s):

The following change was made to the FRANX Fire model:

- Removed the “cable to component” relationships from the database for the following components (68 records):

- 286-B1_1RT4_A_UA
- 286-BE_1ET4_A_UA
- 86-RTA_586_A_UA
- 86-RTC_A_UA

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	1.87E-05	2.07E-05	13.63	$199,511
Percent Reduction	0.2%	40.1%	37.7%	49.9%	50.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 – H/E	5.86E-08	5.08E-07	5.67E-07	9.24E-01	$14,676
ST3 – H/L	3.16E-07	5.91E-06	6.23E-06	1.02E+01	$161,311
ST4 – M/E	1.52E-07	1.42E-06	1.57E-06	1.30E+00	$16,371
ST5 – M/L	1.29E-07	2.94E-06	3.07E-06	8.36E-01	$5,254
ST6 – L/E	1.31E-07	2.10E-06	2.23E-06	3.32E-01	$1,524
ST7 – L/L	1.40E-07	3.79E-07	5.19E-07	3.97E-02	$152
ST8 – LL/E	9.79E-09	1.62E-07	1.72E-07	1.30E-02	$43
ST9 – LL/L	4.18E-08	5.20E-07	5.62E-07	2.67E-02	$81
ST10 – INTACT	1.02E-06	4.73E-06	5.75E-06	9.95E-03	$80
Total	**9.79E-07**	**1.39E-05**	**1.49E-05**	**1.36E+01**	**$199,511**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $4,953,057. After accounting for "round up" of the base internal events and fire cost-risk, this value is $4,953,174. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$4{,}953{,}174 * 1.193 = \$5{,}909{,}137$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 14 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$5,909,137	$5,726,192

Based on a $5,629,397 cost of implementation for CPS, the net value for this SAMA is $96,795 ($5,726,192 - $5,629,397), which indicates this SAMA is potentially cost-beneficial.

6.13 SAMA 15: INSTALL A BATTERY BACKUP TO THE HYDROGEN IGNITERS

While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.

Assumptions:

The failure probability of the battery system to provide adequate power to the igniters for the entire mission time is 0.1.

No operator action is needed to power the igniters when normal power is lost.

The supply is available for both SBO and non-SBO scenarios.

PRA Model Changes to Model SAMA:

A lumped event representing the failure of the battery system to supply power to the igniters has been ANDed with the normal supply for the portions of the logic in which it is explicitly modeled and it has been ANDed with the event representing the presence of a random ignition source for the portions of the logic in which it has already been established that the normal power supply is not available.

Model Change(s):

The following modeling changes were made to the fault tree:

- Gate CGATE104: Created a new AND gate (SAMA-15-1) above gate A1AP72EX. A new basic event (F_SAMA_15) is included in the new AND gate to model failure of the new AC power source.

- Gate CGATE105: Created a new AND gate (SAMA-15-2) above gate A1AP75EX. A new basic event (F_SAMA_15) is included in the new AND gate to model failure of the new AC power source.
- Gate CZ-DW-DEFLAG-SBO: Created a new AND gate (SAMA-15-SBO). Added events 1HIPH-H2IGSBOF–and F_SAMA_15 to SAMA-15-SBO. Deleted 1HIPH-H2IGSBOF–from under CZ-DW-DEFLAG-SBO.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	3.12E-05	3.32E-05	26.34	$391,158
Percent Reduction	0.2%	-0.1%	0.0%	3.2%	3.3%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 – H/E	4.40E-08	5.67E-07	6.11E-07	9.96E-01	$15,824
ST3 – H/L	2.92E-07	1.21E-05	1.24E-05	2.02E+01	$320,904
ST4 – M/E	1.52E-07	4.25E-06	4.40E-06	3.62E+00	$45,796
ST5 – M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,125
ST6 – L/E	1.28E-07	2.95E-06	3.08E-06	4.59E-01	$2,105
ST7 – L/L	1.34E-07	3.79E-07	5.13E-07	3.92E-02	$150
ST8 – LL/E	9.78E-09	1.62E-07	1.72E-07	1.30E-02	$43
ST9 – LL/L	4.16E-08	5.15E-07	5.56E-07	2.65E-02	$81
ST10 – INTACT	1.07E-06	6.84E-06	7.91E-06	1.37E-02	$110
Total	**9.31E-07**	**2.44E-05**	**2.53E-05**	**2.63E+01**	**$391,158**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,467,380. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,467,497. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$9{,}467{,}497 * 1.193 = \$11{,}294{,}724$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 15 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,294,724	$340,605

Based on a $352,000 cost of implementation for CPS, the net value for this SAMA is -$11,395 ($340,605 - $352,000), which indicates this SAMA is potentially cost-beneficial.

6.14 SAMA 17: PROTECT THE EQUIPMENT REQUIRED FOR SRV OPERATION IN THE AUX. BUILDING

In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.

Assumptions:

The SAMA will prevent all environmentally induced failures of the safety relief valves (SRVs).

PRA Model Changes to Model SAMA:

The flag file was used to set the events related to adverse environmental conditions to FALSE.

Model Change(s):

The following events were set to FALSE in the flag files:

- 1OPPH-EN-CLIVF–(ADVERSE AUX BUILDING ENVIRON. CONDITIONS AFFECT SRVs (ATWS))
- 1OPPH-RX-ENVIF–(ADVERSE AUX BLDG ENVIRON CONDITIONS CAUSE FAILURE)
- 1OPPH-CNTFAD-F–(STRUCTURAL BREACH IN CONT. CUASES FAILURE OF ADS)

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	3.12E-05	3.32E-05	27.08	$402,520
Percent Reduction	0.2%	-0.1%	0.0%	0.4%	0.5%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 – BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 – H/E	5.52E-08	8.12E-07	8.67E-07	1.41E+00	$22,461
ST3 – H/L	3.16E-07	1.22E-05	1.26E-05	2.05E+01	$325,179
ST4 – M/E	1.38E-07	4.31E-06	4.44E-06	3.66E+00	$46,211
ST5 – M/L	1.28E-07	3.42E-06	3.54E-06	9.64E-01	$6,060
ST6 – L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 – L/L	1.40E-07	4.02E-07	5.41E-07	4.14E-02	$158
ST8 – LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 – LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 – INTACT	1.04E-06	6.27E-06	7.30E-06	1.26E-02	$101
Total	**9.60E-07**	**2.50E-05**	**2.59E-05**	**2.71E+01**	**$402,520**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,712,826. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,712,943. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,712,943 * 1.193 = \$11,587,541$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 17 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,587,541	$47,788

Based on a $701,000 cost of implementation for CPS, the net value for this SAMA is -$653,212 ($47,788 - $701,000), which indicates this SAMA is not cost-beneficial.

6.15 SAMA 18: INSTALL AN EMERGENCY RCIC STORAGE TANK MAKEUP CAPABILITY FROM SERVICE WATER OPERABLE FROM THE MCR

For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a RCIC Storage Tank makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.

Assumptions:

It is assumed that the plant service water system (WS) is the source of the makeup water to the RCIC storage tank.

It is assumed that the failure probability for this SAMA can be represented by a lumped event with a failure probability of 0.25 that addresses failure of the operators to align the makeup source (including the impacts of dependencies), hardware failures of the makeup line, and support systems dependencies.

PRA Model Changes to Model SAMA:

The assumption that the inventory in the RCIC storage tank in inadequate for the mission time has been set to FALSE. A lumped event representing the ability to provide adequate makeup water to the RCIC storage tank has been added and a failure probability of 0.25 is used, which is appliable in scenarios that require use of the RCIC storage tank for a suction source, including ISLOCA/BOC.

Note: Different failure probabilities could be proposed/supported for the RCIC storage tank makeup function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following changes were made in the fault tree:

- Gate HGATE25: Included a new surrogate basic event (F_SAMA_18) for RCIC tank makeup using WS. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate UGATE23: Included a new surrogate basic event (F_SAMA_18) for RCIC tank makeup using WS. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate XT-CRD: Included existing gate YU1-XZ under it, which allows HPCS with RCIC tank makeup alone to mitigate ISLOCA/BOC/LLOCA sequences and not require other external sources.

The following changes have been made to the flag file:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.95E-06	3.11E-05	3.31E-05	27.17	$404,071
Percent Reduction	2.3%	0.3%	0.4%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE Freq.$_{SAMA}$	Fire Freq.$_{SAMA}$	Total Freq.$_{SAMA}$	Dose-Risk$_{SAMA}$	OECR$_{SAMA}$
ST1 - BOC	3.58E-11	0.00E+00	3.58E-11	1.88E-04	$2
ST2 - H/E	5.85E-08	8.13E-07	8.71E-07	1.42E+00	$22,571
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.05E+01	$326,457
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,367
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,121
ST6 - L/E	1.30E-07	3.07E-06	3.20E-06	4.77E-01	$2,187
ST7 - L/L	1.37E-07	3.79E-07	5.16E-07	3.95E-02	$151
ST8 - LL/E	9.24E-09	1.34E-07	1.43E-07	1.08E-02	$36
ST9 - LL/L	3.94E-08	5.07E-07	5.46E-07	2.60E-02	$79
ST10 - INTACT	9.84E-07	6.15E-06	7.14E-06	1.23E-02	$99
Total	**9.71E-07**	**2.49E-05**	**2.59E-05**	**2.72E+01**	**$404,071**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,740,819. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,740,936. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,740,936 * 1.193 = \$11,620,937$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 18 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,620,937	$14,392

Based on a $2,900,000 cost of implementation for CPS, the net value for this SAMA is -$2,885,608 ($14,392 - $2,900,000), which indicates this SAMA is not cost-beneficial.

6.16 SAMA 19: MODIFY FLEX PROCEDURE FOR FPS MAKEUP TO THE RCIC STORAGE TANK TO ALLOW USE IN NON-ELAP SCENARIOS

For cases in which suppression pool cooling (SPC) is not available or in some LOCA scenarios, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RPV makeup indefinitely.

Assumptions:

The assumption that the inventory in the RCIC storage tank in inadequate for the mission time has been set to FALSE. A lumped event representing the ability to provide adequate makeup water to the RCIC storage tank has been added and a failure probability of 0.25 is used, which is appliable in scenarios that require use of the RCIC storage tank for a suction source.

ISLOCA/BOC events are not assumed to be mitigated due to limited flow from the FPS system to the RCIC storage tank.

Note: Different failure probabilities could be proposed/supported for the RCIC storage tank makeup function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is not cost beneficial.

PRA Model Changes to Model SAMA:

The following changes were made in the fault tree:

- Gate HGATE25: Included a new surrogate basic event (F_SAMA_19) for RCIC tank makeup using FP. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- Gate UGATE23: Included a new surrogate basic event (F_SAMA_19) for RCIC tank makeup using FP. A probability of 0.25 was selected to bound all failure modes, including an operator action to refill the tank.
- ISLOCA Event Tree: Renamed gate YU1-X in the ISLOCA sequences (gates ISLOCA-*) to YU1-X-I. Gate YU1-X-I does not credit the RCIC tank (see gate HGATE61-I for the gate where RCIC tank logic was removed).

The following changes have been made to the flag file:

- Basic event 1HPTKINSUFF24HR- is set to FALSE in the flag file.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	**Fire CDF**	**CDF (Total)**	**Dose-Risk (Total)**	**OECR (Total)**
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.95E-06	3.11E-05	3.31E-05	27.18	$404,090
Percent Reduction	2.3%	0.3%	0.4%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	**FPIE $Freq._{SAMA}$**	**Fire $Freq._{SAMA}$**	**Total $Freq._{SAMA}$**	**Dose-$Risk_{SAMA}$**	**$OECR_{SAMA}$**
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.85E-08	8.13E-07	8.71E-07	1.42E+00	$22,571
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.05E+01	$326,457
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,367
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,121
ST6 - L/E	1.30E-07	3.07E-06	3.20E-06	4.77E-01	$2,187
ST7 - L/L	1.37E-07	3.79E-07	5.16E-07	3.95E-02	$151
ST8 - LL/E	9.24E-09	1.34E-07	1.43E-07	1.08E-02	$36
ST9 - LL/L	3.94E-08	5.07E-07	5.46E-07	2.60E-02	$79
ST10 - INTACT	9.84E-07	6.15E-06	7.14E-06	1.23E-02	$99
Total	**9.71E-07**	**2.49E-05**	**2.59E-05**	**2.72E+01**	**$404,090**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,742,123. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,742,240. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,742,240 * 1.193 = \$11,622,492$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 19 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,622,492	$12,837

Based on a $100,000 cost of implementation for CPS, the net value for this SAMA is -$87,163 ($12,837 - $100,000), which indicates this SAMA is not cost-beneficial.

6.17 SAMA 20: ADDITIONAL DIESEL GENERATOR THAT CAN ACT AS A SWING DIESEL GENERATOR TO ALL DIVISIONS OF AC POWER

Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.

Assumptions:

This SAMA is modeled with a surrogate event that represents the new swing diesel generator. A value of 0.25 was selected as bounding for all failure modes (including operator actions to start the swing diesel generator).

The SAMA diesel generator can power multiple divisions simultaneously.

PRA Model Changes to Model SAMA:

The model was updated to AND the surrogate event with the logic representing existing EDGs 1A, 1B, and 1C such that it can provide power to the same loads when the current EDGs fail.

Note: Different failure probabilities could be proposed/supported for the swing EDG proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following changes were made in the fault tree:

- Added a new surrogate basic event (F_SAMA_20) to the following gates:
  - A1ASUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1A1 (1AP07E))
  - ALASUPPORT-D3 (LOSS OF SUPPORT SYSTEMS FOR BUS 1A1 (1AP07E))
  - A1AP07EX-NO-D3 (NO POWER TO 4KV BUS 1A1 (1AP07E) (NO CREDIT FOR DIV 3 DG XTIE))
  - 1B1SUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1B1 (1AP09E))

- 1C1SUPPORT (LOSS OF SUPPORT SYSTEMS FOR BUS 1C1 (1E22-S004))

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.47E-06	2.30E-05	2.45E-05	18.00	$268,733
Percent Reduction	26.4%	26.2%	26.3%	33.8%	33.5%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	4.49E-08	6.52E-07	6.97E-07	1.14E+00	$18,049
ST3 - H/L	1.14E-07	8.69E-06	8.81E-06	1.44E+01	$228,089
ST4 - M/E	1.35E-07	1.24E-06	1.37E-06	1.13E+00	$14,281
ST5 - M/L	1.37E-07	4.17E-06	4.30E-06	1.17E+00	$7,361
ST6 - L/E	3.06E-08	8.65E-07	8.95E-07	1.33E-01	$612
ST7 - L/L	9.35E-08	3.00E-07	3.93E-07	3.00E-02	$115
ST8 - LL/E	1.94E-09	9.55E-08	9.75E-08	7.37E-03	$25
ST9 - LL/L	3.35E-08	4.99E-07	5.32E-07	2.53E-02	$77
ST10 - INTACT	8.81E-07	6.50E-06	7.38E-06	1.28E-02	$103
Total	**5.91E-07**	**1.65E-05**	**1.71E-05**	**1.80E+01**	**$268,733**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $6,541,235. After accounting for “round up” of the base internal events and fire cost-risk, this value is $6,541,352. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$6,541,352 * 1.193 = \$7,803,833$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 20 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$7,803,833	$3,831,496

Based on a $8,000,000 cost of implementation for CPS, the net value for this SAMA is -$4,168,504 ($3,831,496 - $8,000,000), which indicates this SAMA is not cost-beneficial.

6.18 SAMA 21: ADDRESS FLOW FW DIVERSION IN THE LOSS OF INSTRUMENT AIR PROCEDURE

Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.

Assumptions:

Loss of Instrument Air is no longer assumed to lead to loss of feedwater, or to a flow diversion that fails feedwater flow.

PRA Model Changes to Model SAMA:

The failure of instrument air logic has been removed from the FW flow diversion gate and as a cause of Loss of Feedwater.

Model Change(s):

The following change was made to the fault tree:

- Gate JGATE01 (INSTRUMENT AIR UNAVAILABLE TO TURB BLDG HEADER OR CONTAINMENT/DRYWELL): Removed from gate FGATE99 (SUPPORT SYSTEM FAILURES CAUSE FLOW DIVERSION).
- Gate FGATEIIAI (LOSS OF INSTRUMENT AIR INITIATOR OR FLOODS W/ SAME IMPACT): Removed from gate FW-INITIATORS (INITIATORS THAT CAUSE LOSS OF FW).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,420
Percent Reduction	0.2%	0.0%	0.0%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.86E-08	8.15E-07	8.74E-07	1.42E+00	$22,627
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,636
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,428
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.74E-01	$6,122
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.40E-07	4.02E-07	5.41E-07	4.14E-02	$158
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.02E-06	6.16E-06	7.18E-06	1.24E-02	$100
Total	**9.79E-07**	**2.51E-05**	**2.60E-05**	**2.72E+01**	**$404,420**

Applying the process described in Section F.4 yields an internal events cost-risk of $9,753,493. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,753,610. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,753,610 * 1.193 = \$11,636,057$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 21 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,636,057	($728)

Based on a $30,000 cost of implementation for CPS, the net value for this SAMA is -$30,728 (-$728 - $30,000), which indicates this SAMA is not cost-beneficial.

6.19 SAMA 22: UPGRADE THE ALTERNATE SHUTDOWN PANEL TO INCLUDE ADDITIONAL SYSTEM CONTROL FOR THE OPPOSITE DIVISION

The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.

Assumptions:

The availability of an additional division of system controls provides diversity in hardware availability, but complete dependence is assumed between operator actions performed on the two divisions of equipment controls.

PRA Model Changes to Model SAMA:

The failure probability of the lumped event representing safe shutdown of the plant after MCR evacuation has been changed from 0.1 to 0.05 for non-fire scenarios.

For Fire scenarios, the failure of the “A” train of RHR has been combined with a new event representing the “B” equipment division, which has a failure probability of 0.1. This does not include operator actions, which are addressed by a separate event, and the operation of the second division is assumed to be completely dependent on the first such that the HEPs do not need to be reduced.

Note: Different failure probabilities could be proposed/supported for the event representing safe shutdown of the plant outside the main control room and/or for the additional train of equipment proposed in this SAMA; however, further reducing the failure probabilities will not impact the conclusion that this SAMA is not cost beneficial.

Model Change(s):

The following changes were made to FPIE model:

- Reduced probability for 1XXPH-FLRSPRQH-- (FAILURE TO SHUTDOWN PLANT USING REMOTE SHUTDOWN PANEL) from 0.1 to 0.05 based on the ability to utilize additional divisions of equipment.

The following changes were made to Fire model:

- Gate RSDP-SPC-A (CONTROL OF RHR A FROM THE RSDP FAILS): Created a new AND gate (SAMA-22-SPC) above gate R1SPCX-RSDP (NO TRAIN A SUPP POOL COOLING (RSDP)). Under this new AND gate, a new surrogate event (F_SAMA_22) with a value of 0.1 is included to reflect the additional divisions of equipment that would be available. The existing operator actions for controlling systems from the RSDP remain unchanged and will fail the RSDP function as the action is independent of the division of equipment being operated.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.69E-06	3.12E-05	3.29E-05	27.18	$404,141
Percent Reduction	15.5%	0.0%	1.0%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.77E-08	8.15E-07	8.73E-07	1.42E+00	$22,602
ST3 - H/L	3.12E-07	1.23E-05	1.26E-05	2.05E+01	$326,444
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,394
ST5 - M/L	1.29E-07	3.44E-06	3.57E-06	9.71E-01	$6,104
ST6 - L/E	1.30E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.24E-07	4.02E-07	5.25E-07	4.01E-02	$153
ST8 - LL/E	9.63E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	3.21E-08	5.23E-07	5.55E-07	2.64E-02	$80
ST10 - INTACT	7.44E-07	6.16E-06	6.90E-06	1.19E-02	$96
Total	**9.47E-07**	**2.50E-05**	**2.60E-05**	**2.72E+01**	**$404,141**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,738,067. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,738,184. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,738,067 * 1.193 = \$11,617,654$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 22 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,617,654	$17,675

Based on a $790,000 cost of implementation for CPS, the net value for this SAMA is -$772,325 ($17,675 - $790,000), which indicates this SAMA is not cost-beneficial.

6.20 SAMA 23: AUTOMATIC ATWS LEVEL CONTROL SYSTEM

For failure to scram conditions, early reduction in RPV level is important to limit the heat load sent to the containment, the reliability of which could be improved by automating select ATWS response actions. The logic would be required to actuate without operator interface, only actuate when high pressure injection (e.g., Feedwater system) is available and providing makeup to the RPV, and automatically 1) reduce RPV level to the control band specified in the EOPs, 2) inhibit ADS, and 3) "terminate and prevent injection" from non-Feedwater injection systems. This would increase the time available for the operators to perform the other actions required early in ATWS scenarios, such as MSIV low level isolation logic bypass and SLC injection.

Assumptions:

For this SAMA, it is assumed that the automatic ATWS level control system would only be available if HPCS or Feedwater is available.

Additionally, this SAMA assumes that the automatic ATWS level control system could inhibit ADS and failure to automatically inhibit ADS could be recovered by operators manually inhibiting ADS.

PRA Model Changes to Model SAMA:

The model was modified to incorporate this SAMA by including a surrogate basic event representing the automatic ATWS level control system in the ATWS fault tree logic. For the purposes of this SAMA, a failure probability of 5E-02 is used for the entire automatic system.

Model Change(s):

The following changes were made to the fault tree:

- Gate SLE-ERL-MD: Added new AND gate (SAMA_23_01) with 1RPOP-LC-WMFWH-- and F_SAMA_23 (AUTOMATIC LEVEL CONTROL). This new AND gate replaces 1RPOP-LC-WMFWH--.
- Gate FAIL-ERLY-WFW-L: Replaced 1RPOP-LC-WMFWH-- with gate SAMA_23_01
- Gate LATE-RPV-LEVEL: Replaced 1RPOP-LC-WMFWH-- with gate SAMA_23_01
- Gate OIADS-FW: Changed to AND gate and added F_SAMA_23.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.93E-06	3.12E-05	3.31E-05	27.09	$402,824
Percent Reduction	3.5%	0.0%	0.2%	0.4%	0.4%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	4.49E-08	8.00E-07	8.45E-07	1.38E+00	$21,883
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,754
ST4 - M/E	1.01E-07	4.27E-06	4.37E-06	3.60E+00	$45,458
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	9.73E-01	$6,120
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.40E-07	4.03E-07	5.43E-07	4.15E-02	$159
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.02E-06	6.20E-06	7.22E-06	1.25E-02	$100
Total	**9.14E-07**	**2.50E-05**	**2.59E-05**	**2.71E+01**	**$402,824**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,716,091. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,716,208. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$9{,}716{,}208 * 1.193 = \$11{,}591{,}436$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 23 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,591,436	$43,893

Based on a $1,481,002 cost of implementation for CPS, the net value for this SAMA is -$1,437,109 ($43,893 - $1,481,002), which indicates this SAMA is not cost-beneficial.

6.21 SAMA 24: PROCEDURALIZE USE OF BLACKSTARTECH DC IN NON-ELAP SITUATIONS

Clinton procedure series 4307.01, Blackstartech Portable Battery Powered Coping System, provides instructions for supplying alternate DC power to MCR instruments, Division 1 DC bus, and MOVs supporting FLEX. A potential enhancement would be to modify the procedures to allow use of these procedures (specifically the ability to provide power to the Division 1 DC bus) during non-ELAP conditions.

Assumptions:

The portable system is capable of providing power for the entire 24 hour mission time (procedure provides instructions for recharging the DC cart).

Additionally, this SAMA is solely focused on providing alternate power to the Division 1 DC bus (1DC13E). The other capabilities of the DC cart are not modeled.

PRA Model Changes to Model SAMA:

The model was modified to incorporate this SAMA by including a surrogate basic event representing the alternate DC power to the Division 1 DC bus. This surrogate event represents the required operator actions and potential hardware failures. A failure probability of 5E-02 is used for this surrogate event.

Model Change(s):

The following changes were made to the fault tree:

- Gate D1DC13EX: Added new surrogate event (F_SAMA_24).
- Gate D1DC13EX-D3: Added new surrogate event (F_SAMA_24).

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	**Fire CDF**	**CDF (Total)**	**Dose-Risk (Total)**	**OECR (Total)**
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.87E-06	3.11E-05	3.30E-05	27.18	$404,143
Percent Reduction	6.5%	0.3%	0.7%	0.1%	0.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	**FPIE $Freq._{SAMA}$**	**Fire $Freq._{SAMA}$**	**Total $Freq._{SAMA}$**	**Dose-$Risk_{SAMA}$**	**$OECR_{SAMA}$**
ST1 - BOC	4.88E-10	0.00E+00	4.88E-10	2.57E-03	$23
ST2 - H/E	5.74E-08	8.00E-07	8.57E-07	1.40E+00	$22,207
ST3 - H/L	3.11E-07	1.23E-05	1.26E-05	2.06E+01	$326,625
ST4 - M/E	1.51E-07	4.33E-06	4.48E-06	3.69E+00	$46,602
ST5 - M/L	1.29E-07	3.46E-06	3.59E-06	9.76E-01	$6,137
ST6 - L/E	1.29E-07	3.07E-06	3.20E-06	4.77E-01	$2,188
ST7 - L/L	1.21E-07	3.81E-07	5.02E-07	3.84E-02	$147
ST8 - LL/E	1.07E-09	1.37E-07	1.38E-07	1.04E-02	$35
ST9 - LL/L	4.15E-08	5.22E-07	5.64E-07	2.68E-02	$82
ST10 - INTACT	9.29E-07	6.10E-06	7.03E-06	1.22E-02	$98
Total	**9.41E-07**	**2.50E-05**	**2.59E-05**	**2.72E+01**	**$404,143**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,740,513. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,740,513. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,740,513 * 1.193 = \$11,602,572$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 24 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,620,572	$14,757

Based on a $100,000 cost of implementation for CPS, the net value for this SAMA is -$85,243 ($14,757 - $100,000), which indicates this SAMA is not cost-beneficial.

6.22 SAMA 25: DEVELOP FLOOD AREA-SPECIFIC RESPONSE PROCEDURES

The current flood mitigation strategy relies heavily on operators to identify flood sources and to devise mitigation strategies in an ad-hoc manner. The development of procedures to help the operators systematically review indications to identify flood sources and that provide isolation strategies would potentially improve the reliability of the flooding response actions.

Assumptions:

This SAMA assumes that improvements to the procedures would improve the operator's ability to quickly diagnose the location of the flood and identify the mitigation strategies. The improved scenarios are assumed to include graphically distinct steps to improve the reliability of the cognitive portion of the HEP.

PRA Model Changes to Model SAMA:

The detailed HEP calculations for the flooding isolation actions were modified as follows:

- Time Window: The delay time (td) was reduced by 10 minutes to reflect the operator's ability to quickly identify flood sources and devise a mitigation strategy.
- Cognitive: Cognitive Failure Mode Pce (skip a step in procedure) of the CBDTM method was modified to credit graphically distinct steps.

The list of affected operator actions is provided below:

- 1CCOP-FLNAB--H--, OP FAILS TO ISOLATE CC PIPE RUPTURE IN AREA ABOVE RHRB/C IN AUX. BLDG.
- 1FPOP-FLMABE-H--, OP FAILS TO ISOLATE MAJOR FP PIPE RUPTURE IN AUX. BLDG. (EARLY 2.5 HOURS)
- 1FPOP-FLMABL-H--, OP FAILS TO ISOLATE MAJOR FP PIPE RUPTURE IN AUX. BLDG. (LATE 5.8 HOURS)

- 1FPOP-FLMCB—H--, OP FAILS TO ISOLATE MAJOR FP PIPE RUPTURE IN CTRL. BLDG.
- 1FPOP-FLNCB--H--, OP FAILS TO ISOLATE NOMINAL FP PIPE RUPTURE IN CTRL. BLDG.
- 1SXOP-FLCB781H--, OP FAILS TO ISOLATE SX PIPE RUPTURE IN CB-781' ELECTRICAL AREAS
- 1SXOP-FLMDS—H--, OP FAILS TO ISOLATE SX/WS PIPE RUPTURE IN CTRL. BLDG. / DG BLDG.
- 1SXOP-FLM-SXBH--, OP FAILS TO ISOLATE SX/WS PIPE RUPTURE IN THE SX B VAULT
- 1SXOP-FLNCB--H--, OP FAILS TO ISOLATE NOMINAL SXA/B PIPE RUPTURE IN CTRL. BLDG.
- 1WSOP-FLMABE-H--, OP FAILS TO ISOLATE MAJOR WS PIPE RUPTURE IN AUX. BLDG. (EARLY, 41 MINUTES)
- 1WSOP-FLMABL-H--, OP FAILS TO ISOLATE MAJOR WS PIPE RUPTURE IN AUX. BLDG. (LATE, 1.6 HOURS)
- 1WSOP-FLM-FB-H--, OP FAILS TO ISOLATE MAJOR WS PIPE RUPTURE IN FUEL BLDG.
- 1WSOP-FLM-HPEH--, OP FAILS TO ISOLATE MAJOR WS PIPE RUPTURE IN HPCS ROOM (EARLY, 41 MINUTES)
- 1WSOP-FLM-HPLH--, OP FAILS TO ISOLATE MAJOR WS PIPE RUPTURE IN HPCS ROOM (LATE, 102 MINUTES)

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,384
Percent Reduction	0.0%	-0.1%	0.0%	0.0%	0.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.86E-08	8.15E-07	8.74E-07	1.42E+00	$22,626
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,625
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	3.67E+00	$46,406
ST5 - M/L	1.26E-07	3.45E-06	3.58E-06	9.74E-01	$6,120
ST6 - L/E	1.29E-07	3.09E-06	3.22E-06	4.80E-01	$2,202
ST7 - L/L	1.40E-07	4.02E-07	5.42E-07	4.14E-02	$158
ST8 - LL/E	9.63E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.27E-08	5.23E-07	5.66E-07	2.69E-02	$82
ST10 - INTACT	1.03E-06	6.16E-06	7.19E-06	1.24E-02	$100
Total	**9.74E-07**	**2.51E-05**	**2.60E-05**	**2.72E+01**	**$404,384**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,753,046. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,753,163. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,753,163 * 1.193 = \$11,635,523$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 25 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,635,523	($194)

Based on a $115,000 cost of implementation for CPS, the net value for this SAMA is -$115,194 (-$194 - $115,000), which indicates this SAMA is not cost-beneficial.

6.23 SAMA 26: INCLUDE EXPLICIT STEPS IN THE LOSS OF AC POWER PROCEDURE TO ADDRESS WATER HAMMER

Clinton currently has Alarm Response Procedures (ARPs) that can help operators identify conditions when the ECCS and SX discharge piping is drained and there are steps included that can help prevent water hammer events, but providing explicit steps in the Loss of AC Power procedure would make the required steps more visible and potentially improve the reliability of the action.

Assumptions:

Operator actions 1RHOP-SPCVDE-H-- (FPIE) and 1RHOP-SPCVDE-H-F (Fire) represent operators failing to vent and fill following a loss of offsite power (LOOP) and is currently not credited in the PRA (i.e., HEP is 1.0). This SAMA assumes that these actions are now feasible and can be credited.

PRA Model Changes to Model SAMA:

The HEP values for these actions were set to 5E-02 directly in the baseline cutsets as they were already included in the cutsets as 1.0 values.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.97E-06	2.88E-05	3.08E-05	26.35	$392,153
Percent Reduction	1.5%	7.7%	7.3%	3.1%	3.0%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.85E-08	6.00E-07	6.59E-07	1.07E+00	$17,055
ST3 - H/L	3.13E-07	1.21E-05	1.24E-05	2.02E+01	$321,497
ST4 - M/E	1.52E-07	4.23E-06	4.38E-06	3.61E+00	$45,573
ST5 - M/L	1.20E-07	3.07E-06	3.19E-06	8.68E-01	$5,455
ST6 - L/E	1.30E-07	3.09E-06	3.22E-06	4.80E-01	$2,202
ST7 - L/L	1.40E-07	3.90E-07	5.30E-07	4.05E-02	$155
ST8 - LL/E	9.66E-09	1.62E-07	1.72E-07	1.30E-02	$43
ST9 - LL/L	4.17E-08	4.58E-07	5.00E-07	2.38E-02	$72
ST10 - INTACT	1.00E-06	4.70E-06	5.70E-06	9.87E-03	$79
Total	**9.65E-07**	**2.41E-05**	**2.51E-05**	**2.64E+01**	**$392,153**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,414,927. After accounting for "round up" of the base internal events and fire cost-risk, this value is $9,415,044. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9{,}415{,}044 * 1.193 = \$9{,}415{,}044$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 26 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,232,147	$403,182

Based on a $250,000 cost of implementation for CPS, the net value for this SAMA is $153,182 ($403,182 - $250,000), which indicates this SAMA is potentially cost-beneficial.

6.24 SAMA 27: INSTALL FIRE WRAP / FIRE BARRIER AROUND CRITICAL CABLE RISERS IN FIRE ZONE A-2K

Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall of Fire Zone A-2k (non-safety switchgear room). These cable risers are critical targets within this Fire Zone as they contain cables associated with Division 1 (the Division 1 switchgear room is located directly above Fire Zone A-2k). Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage.

Assumptions:

This SAMA has no significant impact on the FPIE model.

The cable wrap / fire barrier prevents failure of protected cables 100% of the time.

PRA Model Changes to Model SAMA:

The Fire model was modified to remove specific cable risers as potential fire-induced targets.

Model Change(s):

The following changes were made the FRANX Fire model:

- Removed the “zone to raceway” relationships for risers 16R9, 16R10, 16R19, 16R20, and 16R21 in Fire Zone A-2k.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	2.52E-05	2.72E-05	19.53	$282,699
Percent Reduction	0.0%	19.2%	18.1%	28.2%	30.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.86E-08	6.00E-07	6.59E-07	1.07E+00	$17,058
ST3 - H/L	3.16E-07	7.80E-06	8.12E-06	1.32E+01	$210,215
ST4 - M/E	1.52E-07	4.35E-06	4.50E-06	3.71E+00	$46,823
ST5 - M/L	1.29E-07	3.46E-06	3.59E-06	9.76E-01	$6,137
ST6 - L/E	1.31E-07	2.91E-06	3.04E-06	4.53E-01	$2,080
ST7 - L/L	1.40E-07	4.00E-07	5.40E-07	4.12E-02	$158
ST8 - LL/E	9.79E-09	1.58E-07	1.68E-07	1.27E-02	$42
ST9 - LL/L	4.18E-08	5.22E-07	5.64E-07	2.68E-02	$82
ST10 - INTACT	1.02E-06	5.00E-06	6.02E-06	1.04E-02	$84
Total	**9.79E-07**	**2.02E-05**	**2.12E-05**	**1.95E+01**	**$282,699**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $6,981,466. After accounting for "round up" of the base internal events and fire cost-risk, this value is $6,981,583. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$6,981,583 * 1.193 = \$8,329,029$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 27 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$8,329,029	$3,306,300

Based on a $1,121,838 cost of implementation for CPS, the net value for this SAMA is $2,184,462 ($3,306,300 - $1,121,838), which indicates this SAMA is potentially cost-beneficial.

6.25 SAMA 28: REROUTE RISK-SIGNIFICANT CONDUITS IN FIRE ZONE CB-5A TO FIRE ZONE CB-1G

The Division 3 Switchgear Room (CB-5a) is located south of the Division 1 Cable Spreading Room (CB-4) in the Control Building. Conduits C0734 and C0818, which support Division 1 equipment, are routed through CB-5a before they enter Fire Zone CB-5c, which is a small riser aisle that is used to route cables to different elevations in the Control Building. Rerouting these conduits through Fire Zone CB-1g, which is east of both CB-5a and CB-4 would reduce the risk-significance of fires originating in CB-5a.

Assumptions:

This SAMA has no significant impact on the FPIE model.

The rerouted conduits are assumed to be failed for all fires originating in Fire Zone CB-1g (i.e., detailed routing was not proposed / identified for this SAMA).

PRA Model Changes to Model SAMA:

The Fire model was modified to move the specific conduits from Fire Zone CB-5a to CB-1g.

Model Change(s):

The following changes were made to the FRANX Fire model:

- Removed the “zone to raceway” relationships for conduits C0734 and C0818 in Fire Zone CB-5a.
- Added the “zone to raceway” relationships for conduits C0734 and C0818 to Fire Zone CB-1g.

Results of SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	2.00E-06	2.93E-05	3.13E-05	26.02	$389,416
Percent Reduction	0.0%	6.1%	5.7%	4.3%	3.7%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.86E-08	8.00E-07	8.59E-07	1.40E+00	$22,238
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	2.06E+01	$326,765
ST4 - M/E	1.52E-07	2.90E-06	3.05E-06	2.51E+00	$31,743
ST5 - M/L	1.29E-07	3.42E-06	3.55E-06	9.65E-01	$6,069
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.40E-07	3.99E-07	5.39E-07	4.12E-02	$157
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.27E-07	5.69E-07	2.71E-02	$82
ST10 - INTACT	1.02E-06	5.70E-06	6.72E-06	1.16E-02	$93
Total	**9.79E-07**	**2.36E-05**	**2.46E-05**	**2.60E+01**	**$389,416**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $9,355,266. After accounting for “round up” of the base internal events and fire cost-risk, this value is $9,355,383. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{SAMA} = \$9,355,383 * 1.193 = \$11,160,972$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 28 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
$11,635,329	$11,160,972	$474,357

Based on a $3,250,000 cost of implementation for CPS, the net value for this SAMA is -$2,775,643 ($474,357 - $3,250,000), which indicates this SAMA is not cost-beneficial.

7.0 SENSITIVITY ANALYSIS

NEI 05-01 recommends that applicants perform sensitivity analyses that evaluate how changes to certain assumptions and uncertainties in the SAMA analysis would affect the cost-benefit analysis outcome. Accordingly, the following uncertainties were further investigated as to their impact on the overall SAMA evaluation:

- Use of a discount rate of 7 percent, instead of 3 percent used in the base case analysis.
- Use of the 95th percentile PRA results in place of the point estimate PRA results.
- Variations in selected WinMACCS input variables.
- Inclusion of the reliable hard pipe vent on potentially cost-beneficial SAMAs

7.1 REAL DISCOUNT RATE

In this sensitivity case, the Phase 1 and Phase 2 results were re-evaluated using the 7 percent RDR suggested in NUREG/BR-0184.

For the Phase 1 analysis, the MACR was recalculated be to $8,408,264 (a 28 percent reduction of the baseline MACR), no additional SAMAs would be screened in the Phase 1 analysis due to the use of the 7 percent RDR.

For the Phase 2 analysis, the determination of cost effectiveness changed for one of the Phase 2 SAMAs when the 7 percent RDR was used in lieu of 3 percent, as shown below.

Summary of the Impact of the RDR Value on the Detailed SAMA Analyses

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (3 percent RDR)	Net Value (3 percent RDR)	Averted Cost Risk (7 percent RDR)	Net Value (7 percent RDR)	Change in Cost Effective-ness?
SAMA 1	Not Used					
SAMA 2	$50,000	$314,376	$264,376	$228,686	$178,686	No
SAMA 3	$8,915,554	$331,011	-$8,584,543	$237,711	-$8,677,843	No
SAMA 4	$12,940,000	$4,600,632	-$8,339,368	$3,316,048	-$9,623,952	No
SAMA 5	$400,000	$104,930	-$295,070	$75,776	-$324,224	No
SAMA 6	$475,000	$21,408	-$453,592	$16,482	-$458,518	No
SAMA 7	$250,000	$112,962	-$137,038	$81,753	-$168,247	No

Summary of the Impact of the RDR Value on the Detailed SAMA Analyses

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (3 percent RDR)	Net Value (3 percent RDR)	Averted Cost Risk (7 percent RDR)	Net Value (7 percent RDR)	Change in Cost Effective-ness?
SAMA 8	$1,828,302	$125,749	-$1,702,553	$91,181	-$1,737,121	No
SAMA 9	$635,242	$13,860	-$621,382	$9,994	-$625,248	No
SAMA 10	$649,194	$476,001	-$173,193	$347,013	-$302,181	No
SAMA 11	$600,000	-$172	-$600,172	-$156	-$600,156	No
SAMA 12	$100,000	$93,011	-$6,989	$66,973	-$33,027	No
SAMA 13	Not Used					
SAMA 14	$5,629,397	$5,726,192	$96,795	$4,128,476	-$1,500,921	Yes
SAMA 15	$352,000	$340,605	-$11,395	$243,717	-$108,283	No
SAMA 16	Not Used					
SAMA 17	$701,000	$47,788	-$653,212	$34,165	-$666,835	No
SAMA 18	$2,900,000	$14,392	-$2,885,608	$10,651	-$2,889,349	No
SAMA 19	$100,000	$12,837	-$87,163	$9,538	-$90,462	No
SAMA 20	$8,000,000	$3,831,496	-$4,168,504	$2,763,249	-$5,236,751	No
SAMA 21	$30,000	-$728	-$30,728	-$554	-$30,554	No
SAMA 22	$790,000	$17,675	-$772,325	$13,421	-$776,579	No
SAMA 23	$1,481,002	$43,893	-$1,437,109	$31,581	-$1,449,421	No
SAMA 24	$100,000	$14,757	-$85,243	$11,121	-$88,879	No
SAMA 25	$115,000	-$194	-$115,194	-$179	-$115,179	No
SAMA 26	$250,000	$403,182	$153,182	$294,466	$44,466	No
SAMA 27	$1,121,838	$3,306,300	$2,184,462	$2,380,775	$1,258,937	No
SAMA 28	$3,250,000	$474,357	-$2,775,643	$344,116	-$2,905,884	No

7.2 95TH PERCENTILE PRA RESULTS

This sensitivity uses the 95th percentile results to examine the impact of uncertainty in the PRA model.

Because both the fire model and the FPIE model were directly used in the CPS SAMA quantifications, it was necessary to determine how to reflect the impact of the 95th percentile results of each model on the SAMA quantifications. The approach chosen was to use the larger ratio of the 95th percentile CDF to the point estimate CDF from the FPIE and fire models to represent the results for both models. For CPS, the larger ratio is based on the Fire model results.

The results of the uncertainty calculation show that the 95th percentile Fire CDF is 9.62E-05/yr, which is a factor of 3.08 greater than the CPS CL122AF0 Fire CDF point estimate of 3.12E-05/yr. Therefore, for this analysis, the 95th percentile multiplier derived from the base case is used to examine the change in the cost benefit for each SAMA.

7.2.1 Phase 1 Impact

For Phase 1 screening, use of the 95th percentile PRA results will increase the MACR and may prevent the screening of some of the higher cost modifications. However, the impact on the overall SAMA results due to the retention of the higher cost SAMAs for Phase 2 analysis is typically small. This is due to the fact that the benefit obtained from the implementation of those SAMAs must be extremely large in order to be cost-beneficial.

The impact of uncertainty in the PRA results on the Phase 1 SAMA analysis has been examined. The MACR is the primary Phase 1 criterion affected by PRA uncertainty. Thus, this portion of the sensitivity is focused on recalculating the MACR using the 95th percentile PRA results and re-performing the Phase 1 screening process. As discussed above, the 95th PRA results are a factor of 3.08 greater than the point estimate CDF.

In order to simulate the use of the 95th percentile PRA results on the cost benefit calculations, the same scaling factor calculated for the Level 1 results was assumed to apply to the Level 3 results. Because the MACR calculations scale linearly with the CDF, dose-risk, and off-site economic cost-risk, the 95th percentile MACR can be calculated by multiplying the base case MACR by 3.08. This results in a 95th percentile MACR of $35,836,813.

The initial SAMA list has been re-examined using the revised MACR to identify SAMAs that would have been retained for the Phase 2 analysis. Those SAMAs that were previously screened due to costs of implementation that exceeded $11,635,329 are now retained if the costs of implementation are less than $35,836,813. For the baseline results, only SAMA 4 was screened on cost in Phase 1. Using the 95th percentile MACR, no SAMAs are screened on cost in Phase 1 (i.e., SAMA 4 is retained for Phase 2 analysis using 95th percentile results). Therefore, the increase in the MACR to the 95th percentile value resulted in the retention of a single SAMA that would have otherwise have been screened on high implementation cost.

Based on a detailed quantification for SAMA 4, a new averted cost risk and net value at the 95th percentile were generated. As shown below, this SAMA is highly effective for CPS and when the 95th percentile PRA results are used, the SAMA is potentially cost beneficial.

7.2.1.1 SAMA 4: Enhance Containment Venting Capability (e.g., FLEX Hardpipe Vent)

The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.

Assumptions:

This SAMA can be modeled using a lumped event with a failure probability of 0.5 that represents hardware failures, independent operator action failure, and dependent operator action failures.

PRA Model Changes to Model SAMA:

The flag event that is used to identify the inability of other CPS containment vent paths to remove adequate heat/pressure from the containment has been changed from a TRUE event to a basic event with a probability of 0.5.

Note: Different failure probabilities could be proposed/supported for the containment venting function proposed in this SAMA; however, further reducing the failure probability will not impact the conclusion that this SAMA is potentially cost beneficial.

Model Change(s):

The following modeling changes were made:

- 1CVPH-SMALLD-F-- (SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4): Basic event changed from TRUE to have a probability of 0.5.

SAMA Quantification:

The following table summarizes the changes to the internal events, Fire, and total CDFs, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	FPIE CDF	Fire CDF	CDF (Total)	Dose-Risk (Total)	OECR (Total)
Base Value	2.00E-06	3.12E-05	3.32E-05	27.20	$404,403
SAMA Value	1.86E-06	2.16E-05	2.35E-05	16.45	$238,063
Percent Reduction	6.8%	30.6%	29.2%	39.5%	41.1%

A further breakdown of the Dose-Risk and OECR information is provided in the table below according to release category:

Release Category	FPIE $Freq._{SAMA}$	Fire $Freq._{SAMA}$	Total $Freq._{SAMA}$	Dose-$Risk_{SAMA}$	$OECR_{SAMA}$
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	2.36E-03	$21
ST2 - H/E	5.72E-08	5.59E-07	6.16E-07	1.00E+00	$15,960
ST3 - H/L	2.27E-07	6.35E-06	6.58E-06	1.07E+01	$170,381
ST4 - M/E	1.51E-07	4.26E-06	4.41E-06	3.63E+00	$45,838
ST5 - M/L	8.02E-08	1.87E-06	1.95E-06	5.31E-01	$3,337
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	4.80E-01	$2,203
ST7 - L/L	1.04E-07	3.10E-07	4.14E-07	3.17E-02	$121
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	1.31E-02	$44
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	2.69E-02	$82
ST10 - INTACT	1.06E-06	4.52E-06	5.58E-06	9.66E-03	$78
Total	**8.02E-07**	**1.71E-05**	**1.79E-05**	**1.65E+01**	**$238,063**

Applying the process described in Section F.4 yields an internal events and fire cost-risk of $5,896,528. After accounting for “round up” of the base internal events and fire cost-risk, this value is $5,896,645. The external events contributions are accounted for by multiplying this value by 1.193:

$$\text{Total Cost-Risk}_{\text{SAMA}} = \$5{,}896{,}645 * 1.193 = \$7{,}034{,}679$$

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in the following table:

SAMA 4 Averted Cost-Risk

Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
11,635,329	$7,034,697	$4,600,632

Based on a $12,940,000 cost of implementation for CPS, the base case net value for this SAMA is -$8,339,368 ($4,600,632 - $12,940,000). When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.08 to $14,196,947, which yields a positive net value of $1,229,947 ($14,196,947 - $12,940,000 = $1,229,947) and indicates this SAMA is potentially cost-beneficial.

7.2.2 Phase 2 Impact

As discussed above, a single factor based on the 95th percentile CDF value from the baseline fire model is used to determine the impact of the cost-benefit analysis for the proposed SAMA candidates. The uncertainty analyses that are available for the Level 1 model are not available (or not used) for the full spectrum of Level 2 release categories or the Level 3 models. In order to simulate the use of the 95th percentile results for the Level 2 and 3 models, the same scaling factor calculated for the Level 1 results was implicitly applied to the dose-risk and offsite economic cost-risk through the application of the multiplier to the base case averted cost-risk values.

The Phase 2 SAMA list was re-examined by multiplying the nominal averted cost-risk by the ratio of the 95th percentile CDF to the point estimate CDF value to identify SAMAs that would be re-characterized as potentially cost-beneficial, i.e., positive net value. Those SAMAs that were previously determined to be not cost-beneficial due to implementation costs exceeding their associated nominal averted cost risk values may be potentially cost-beneficial at the revised 95th percentile averted cost risk. In this case, five additional Phase 2 SAMAs from the baseline analysis become potentially cost-beneficial (SAMAs 7, 10, 12, 15, and 20) and the additional SAMA that was retained from the Phase I analysis (SAMA 4) was also shown to be potentially cost beneficial.

7.2.3 95th Percentile Summary

The following table provides a summary of the impact of using the 95th percentile PRA results on the detailed cost-benefit calculations that have been performed.

Summary of the Impact of Using the 95th Percentile PRA Results

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (Base)	Net Value (Base)	Averted Cost Risk (95th Percentile)	Net Value (95th Percentile)	Change in Cost Effective-ness?
SAMA 1	Not Used					
SAMA 2	$50,000	$314,376	$264,376	$968,278	$918,278	No
SAMA 3	$8,915,554	$331,011	-$8,584,543	$1,019,514	-$7,896,040	No
SAMA 4	$12,940,000	$4,600,632	-$8,339,368	$14,169,947	$1,229,947	Yes
SAMA 5	$400,000	$104,930	-$295,070	$323,184	-$76,816	No
SAMA 6	$475,000	$21,408	-$453,592	$65,937	-$409,063	No
SAMA 7	$250,000	$112,962	-$137,038	$347,923	$97,923	Yes
SAMA 8	$1,828,302	$125,749	-$1,702,553	$387,307	-$1,440,995	No
SAMA 9	$635,242	$13,860	-$621,382	$42,689	-$592,553	No
SAMA 10	$649,194	$476,001	-$173,193	$1,466,083	$816,889	Yes
SAMA 11	$600,000	-$172	-$600,172	-$530	-$600,530	No
SAMA 12	$100,000	$93,011	-$6,989	$286,474	$186,474	Yes
SAMA 13	Not Used					
SAMA 14	$5,629,397	$5,726,192	$96,795	$17,636,671	$12,007,274	No
SAMA 15	$352,000	$340,605	-$11,395	$1,049,063	$697,063	Yes
SAMA 16	Not Used					
SAMA 17	$701,000	$47,788	-$653,212	$147,187	-$553,813	No
SAMA 18	$2,900,000	$14,392	-$2,885,608	$44,327	-$2,855,673	No
SAMA 19	$100,000	$12,837	-$87,163	$39,538	-$60,462	No
SAMA 20	$8,000,000	$3,831,496	-$4,168,504	$11,801,008	$3,801,008	Yes
SAMA 21	$30,000	-$728	-$30,728	-$2,242	-$32,242	No
SAMA 22	$790,000	$17,675	-$772,325	$54,439	-$735,561	No
SAMA 23	$1,481,002	$43,893	-$1,437,109	$135,190	-$1,345,812	No
SAMA 24	$100,000	$14,757	-$85,243	$45,452	-$54,548	No
SAMA 25	$115,000	-$194	-$115,194	-$598	-$115,598	No
SAMA 26	$250,000	$403,182	$153,182	$1,241,801	$991,801	No
SAMA 27	$1,121,838	$3,306,300	$2,184,462	$10,183,404	$9,061,566	No
SAMA 28	$3,250,000	$474,357	-$2,775,643	$1,461,020	-$1,788,980	No

The use of the 95th percentile PRA results is not considered to provide the best assessment of the cost-effectiveness of a SAMA. Instead, it is intended to address the uncertainties inherent in the SAMA analysis. Nonetheless, these additional SAMAs identified as potentially cost-beneficial through this sensitivity case (none of which is related to aging management under 10 C.F.R. Part 54) should be further evaluated for possible implementation using current, applicable plant procedures.

7.3 WINMACCS INPUT VARIATIONS

The Level 3 WinMACCS model involves numerous inputs and modeling choices that are subject to alternative values as discussed in Section F.3. A number of WinMACCS sensitivity cases were presented in Section 7.3 to examine the potential impact of different inputs.

Two documents finalized in 2022 are specifically examined in this section with respect to the potential impact upon the Level 3 modeling and results.

7.3.1 2022 Evacuation Time Estimate Study

The CPS Level 3 WinMACCS model incorporated some population inputs and protective action modeling for evacuation based on the 2014 CPS Evacuation Time Estimate (ETE) study (KLD 2014). In 2022, a new ETE was finalized for CPS (KLD 2022). The potential impact of the differences between the two ETEs are addressed.

7.3.1.1 Population Estimates

The 2014 CPS ETE was based on 2010 census data and community demographic surveys conducted in 2011. The 2022 CPS ETE was based on 2020 census data and community demographic surveys conducted between December 2020 and March 2022. The 2022 CPS ETE was also based on the recently released NUREG/CR-7002 Revision 1 (NRC 2021).

Population data obtained from the 2014 ETE was limited to the transient population within the 10-mile EPZ and totaled 8,433 persons. As discussed in Section F.3.2, this transient population was added to the 2010 census permanent population from SecPop prior to projection to year 2047. This transient data included visitors to the area such as lodging, campground, parks, marinas, as well as employees, schools/daycares, and medical facilities identified in the 2014 ETE.

Review of the 2022 ETE identifies a corresponding total transient population that would be added for projection of 7,917 persons, approximately 6% less than that developed from the 2014 ETE.

Therefore, use of the 2014 ETE is judged conservative as compared to use of the 2022 ETE with respect to transient population data.

7.3.1.2 Evacuation Parameters

The Level 3 WinMACCS model includes two protective actions parameters (i.e., evacuation delay and evacuation speed) whose values were developed based on the 2014 CPS ETE and evaluated with sensitivity cases. Had the 2022 CPS ETE been used, the delay to evacuation would increase and the evacuation speed would decrease, as shown in the table below.

The values used for the sensitivity cases (discussed in Section 7.3) are also presented in the table below and show that the sensitivity cases bound the evacuation delay and evacuation speed values developed from the 2022 ETE.

	Evacuation Delay (min)		Evacuation Speed (m/s)	
Case	**Cohort 1**	**Cohort 2**	**Cohort 1**	**Cohort 2**
2014 ETE Based Values	57	105	4.0	2.4
2022 ETE Based Values	79	131	3.5	2.3
F.7.3 Delay Sensitivity	114	157.5	--	--
F.7.3 Speed Sensitivity	--	--	2.0	1.2

The Section 7.3 evacuation sensitivity case results demonstrate that the evacuation delay and evacuation speed have <0.5% impact on the 50-mile dose-risk and essentially no impact on the cost risk.

Based upon the above discussion, use of the CPS 2022 ETE as the basis for the WinMACCS modeling in lieu of the 2014 ETE would have a negligible impact on the Level 3 results.

7.3.2 NUREG/CR-7270 Technical Bases for Consequence Analyses

NUREG/CR-7270 (NRC 2022b) was published in October 2022 and represents updated technical bases for values used in WinMACCS modeling applications. Prior to its publication, the most recent technical bases were NUREG/CR-7009 (NRC 2014) based on the extensive Level 3 work from the NRC's State-of-the-Art Reactor Consequence Analysis (SOARCA), as augmented in the WinMACCS User's Guide (Sandia 2021) and representation in the WinMACCS sample problems distributed with the WinMACCS code. As documented in Section F.3, the CPS WinMACCS model started with the WinMACCS LNT point estimate sample problem and followed recommendations included in NUREG/CR-7009 and the WinMACCS User's Guide.

Following its recent publication, NUREG/CR-7270 was reviewed for potential impact to CPS modeling choices. NUREG/CR-7270 contains minor changes to a variety of inputs that are not qualitatively estimated to exceed the range of WinMACCS sensitivity case results presented in Section F.7.3. The lone exception is decontamination modeling, specifically the changes associated with the decontamination levels, times, and costs in NUREG/CR-7270. While NUREG/CR-7009 maintained the historic modeling approach of two dose reduction factor (DRF) levels of 3 and 15, NUREG/CR-7270 proposes three DRF levels of 2, 4, and 8, with decontamination costs that are substantially higher than those identified in NUREG/CR-7009.

To examine the potential impact of these decontamination modeling differences a sensitivity case was conducted using revised decontamination inputs from NUREG/CR-7270 as identified in Table 7.3-1. It is noted that some inputs did decrease in NUREG/CR-7270.

The NUREG/CR-7270 decontamination sensitivity case showed an increase in 50-mile population dose risk of approximately 4% (to 71.1 rem/yr) and an increase in 50-mile cost risk of approximately 61% (to $1.55E+6/yr). While the increase in cost risk is larger than most other sensitivity cases documented in Section 7.3, it is within the bounds of the uncertainty considerations incorporated into the SAMA assessment, as discussed in the next section.

7.3.3 Impact on SAMA Analysis

Several different Level 3 input parameters and modeling assumptions are examined as part of the CPS WinMACCS sensitivity analysis. The primary reason for performing these sensitivity runs is to identify any reasonable changes that could be made to the Level 3 input parameters that would impact the conclusions of the SAMA analysis. While the table in Section 7.3 summarizes the changes to the dose-risk and OECR estimates for each sensitivity case, it is prudent to consider if any of these changes would result in the retention of the SAMAs that were screened using the baseline results.

Of all the WinMACCS sensitivity cases, the largest dose-risk increase is associated with the 95th percentile weather which increases by 74%, a factor of approximately 1.75. Similarly, the largest OECR increase is also associated with the 95th percentile weather which increases by approximately 120%, a factor of approximately 2.20. While these changes are not insignificant, they are bounded by the 95th percentile CDF PRA results sensitivity in Section 7.2, which increases the averted cost-risk values for the SAMAs by a factor of 3.08. Therefore, the 95th percentile CDF PRA results sensitivity case is considered to bound Level 3 95th percentile weather variability case and no SAMAs would be retained based on this sensitivity that were not already identified in Section 7.2.

8.0 CONCLUSIONS

Using a SAMA methodology consistent with NEI 05-01, SAMAs 2, 14, 26, and 27 were found to be potentially cost-beneficial in the baseline analysis.

When the 95th percentile PRA results are considered, SAMAs 4, 7, 10, 12, 15, and 20 are also potentially cost-beneficial.

None of the SAMAs identified as potentially cost-beneficial are aging related.

8.1 OPTIMAL SAMA SET

While many SAMAs are potentially cost-beneficial for CPS when considered independently, it should be noted that many SAMAs address similar areas of risk. Implementation of one SAMA may result in a change in the potential benefits of the remaining SAMAs, such that they are no longer cost-beneficial. Review of the potentially cost-beneficial SAMAs can help identify an “optimal” set of SAMAs for implementation; that is, a reduced set of SAMAs that will address the largest risk contributors for the site. For example, the reliable hard pipe containment vent (SAMA 4) would provide venting capability without any support systems and, if implemented, would preclude the need for the procedure update to use the FLEX generators to provide power to the existing containment vent valves in non-ELAP scenarios (SAMA 12). It is recognized that there are different combinations of SAMAs that could achieve similar results, but this is a demonstration of a potential approach to interpreting the results of the cost benefit analysis.

Generally, implementing one SAMA in a group of functionally similar SAMAs would render the remaining SAMAs in the group non-cost-beneficial. The following table categorizes the potentially cost-beneficial SAMAs listed in Section 8.0 and discusses the implications of SAMA implementation.

Impact of SAMA Implementation by Functional Group

SAMA Functional Group	SAMA Title	Discussion
Containment Heat Removal	SAMA 4: Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	At CPS, the current containment venting process relies on equipment for which electrical and instrument air support is required, and the vent valves may not function in some of the severe accident conditions in which containment venting would be required. SAMA 4 would provide a means of venting without support systems; hence, SAMA 12 would not be required if SAMA 4 were implemented. SAMA 20 would help maintain power to ECCS pumps and suppression pool cooling such that containment venting would not be required and SAMAs 4 and 12 would no longer be potentially cost beneficial.
	SAMA 12: Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	
RPV Inventory Control	SAMA 7: Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	SAMA 7 is designed to allow continued use of those pumps that take suction from the suppression pool when containment conditions are adverse. SAMA 10 would provide a means of injecting when there is no AC power to the ECCS pumps and it does not rely on the suppression pool; therefore, implementation of SAMA 10 would likely reduce the benefit of SAMA 7 such that it would no longer be cost beneficial. SAMA 20 would help maintain power to ECCS pumps and suppression pool cooling and implementation of SAMA 20 would lead to SAMAs 7 and 10 being not cost beneficial.
	SAMA 10: Install a Hard Piped Connection Between FPS and RHR	
Electrical	SAMA 2: Proceduralize DC Current Check for ELAP Load Shed Action	SAMA 2 is a low cost change to help mitigate SBO scenarios. SAMAs 14 and 20 each address different causes of AC power failure; however, SAMA 20 would reduce the scenarios that would require SAMA 2 and mitigate scenarios in which fires would damage cables related to offsite power distribution that would require SAMA 14. It would also reduce the frequency of scenarios in which containment heat removal is lost, which could reduce the benefit of SAMA 4 to the point where they may no longer be cost beneficial. SAMA 15 may also no longer be cost beneficial given that the frequency of loss of power to the igniters would be significantly reduced.
	SAMA 14: Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	
	SAMA 20: Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	

Impact of SAMA Implementation by Functional Group

SAMA Functional Group	SAMA Title	Discussion
Containment Integrity	SAMA 15: Install a Battery Backup to the Hydrogen Igniters	Implementation of SAMA 15 would reduce the benefit of SAMAs that improve AC power reliability; however, the change would likely not be enough to make other SAMAs not cost beneficial. Implementation of SAMAs that improve AC power availability, such as SAMA 20, would likely reduce the benefit of SAMA 15 to the point where it may no longer be cost beneficial.
Fire	SAMA 27: Install fire wrap / fire barrier around critical risers in Fire Zone A-2k	Other SAMAs, such as installation of an additional diesel generator (SAMA 20) and protecting offsite power with cable wrap (SAMA 14) address some of the same risks, but likely not enough to change the status of SAMA 27.
Other	SAMA 26: Include explicit steps in the loss of AC power procedure to address water hammer	The risk from water hammer is unique to a specific condition when offsite power is lost and it does not overlap significantly with other areas of risk. Implementation of other SAMAs is not expected to impact the status of this SAMA.

While a large number of SAMAs can be considered potentially cost-beneficial for CPS when considered independently, there is a smaller subset of SAMAs that, if implemented, would render the remaining SAMAs “not cost-beneficial”. This subset consists of SAMAs 20, 26, and 27.

9.0 TABLES

Table 2.3.1-1
Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%LOOP	Loss of Offsite Power	Transient	2.32E-02	37.87%	7.56E-07	3.26E-05
%FLFPMMCR	Major FP Rupture Above MCR	Flooding	8.68E-05	20.32%	4.06E-07	4.67E-03
%OPC-RAT	OPC Occurs Upstream of RAT B	Special	2.90E-03	7.73%	1.54E-07	5.32E-05
%TT	Turbine Trip	Transient	2.20E-01	5.37%	1.07E-07	4.87E-07
%FLVCMMCR	Major VC Rupture in CB-1i Above MCR	Flooding	1.89E-05	4.43%	8.84E-08	4.67E-03
%FLWSMAB	Major Service Water Rupture in AB	Flooding	1.58E-04	3.71%	7.40E-08	4.68E-04
%FLSXAMMCR	Major SX A Rupture Above MCR	Flooding	1.26E-05	2.95%	5.89E-08	4.67E-03
%FLSXBMMCR	Major SX B Rupture Above MCR	Flooding	1.26E-05	2.95%	5.89E-08	4.67E-03
%MS	Manual Shutdown	Transient	1.50E+00	2.16%	4.31E-08	2.88E-08
%FLFPMAB	Major Fire Protection Water Rupture in AB	Flooding	8.89E-04	1.21%	2.41E-08	2.71E-05
%TF	Loss of Feedwater	Transient	3.94E-02	1.15%	2.29E-08	5.81E-07
%S2-WA	Small LOCA (Below TAF)	LOCA	1.59E-04	0.89%	1.78E-08	1.12E-04
%TIA	Loss of Instrument Air	Special	1.55E-02	0.85%	1.69E-08	1.09E-06
%TC	Loss of Condenser Vacuum	Transient	3.12E-02	0.79%	1.59E-08	5.09E-07
%CCW	Loss of CCW	Special	1.00E+00	0.77%	1.53E-08	1.53E-08
%FLSXBNSXB	Nominal SX/WS Pipe Rupture in SX B Room	Flooding	1.26E-04	0.65%	1.30E-08	1.03E-04
%FLSXBMCB3A	Major SX B Rupture in Fire Area CB-3a	Flooding	9.24E-06	0.61%	1.21E-08	1.31E-03
%FLSXBNCB3A	Nominal SX B Rupture in Fire Area CB-3a	Flooding	5.50E-05	0.46%	9.13E-09	1.66E-04
%TAC12E	Loss of 480 V Bus 0AP12E	Special	5.20E-04	0.43%	8.60E-09	1.65E-05
%FLSXBMSXB	Major SX/WS Pipe Rupture in SX B Room	Flooding	2.09E-05	0.41%	8.15E-09	3.90E-04
%TAC11E	Loss of 480 V Bus 0AP11E	Special	5.20E-04	0.40%	8.01E-09	1.54E-05

Table 2.3.1-1

Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%FLWSNMCBTBSH	Nominal or Major Service Water rupture In the Control, Turbine, or Screenhouse buildings	Flooding	3.17E-03	0.36%	7.17E-09	2.26E-06
%OPC-ERAT	OPC Occurs Upstream of ERAT	Special	2.90E-03	0.33%	6.62E-09	2.28E-06
%TBCCW	Loss of TBCCW	Special	1.00E+00	0.30%	6.01E-09	6.01E-09
%S2-ST	Small LOCA (Above TAF)	LOCA	1.63E-04	0.28%	5.56E-09	3.41E-05
%TI	Inadvertent Open Relief Valve	Transient	8.14E-03	0.25%	5.06E-09	6.22E-07
%S1-ST	Medium LOCA above TAF (steam LOCA)	LOCA	4.35E-05	0.24%	4.83E-09	1.11E-04
%TM	MSIV Closure	Transient	9.19E-03	0.22%	4.41E-09	4.80E-07
%FLWSMHPCS	Major Service Water Rupture in HPCS Room	Flooding	1.60E-05	0.21%	4.10E-09	2.56E-04
%S1-WA	Medium LOCA below TAF (water LOCA)	LOCA	2.79E-05	0.15%	3.07E-09	1.10E-04
%TAC4E	Loss of 6.9 KV Bus 1AP04E	Special	3.12E-03	0.15%	3.04E-09	9.75E-07
%TAC5E	Loss of 6.9 KV Bus 1AP05E	Special	3.12E-03	0.11%	2.26E-09	7.24E-07
%TAC6E	Loss of 4 KV Bus 1AP06E	Special	2.02E-03	0.09%	1.88E-09	9.30E-07
%R	Excessive LOCA	LOCA	1.00E-08	0.09%	1.82E-09	1.82E-01
%FLCWNM	Nominal or Major Circulating Water Rupture in Turbine Building or Screenhouse	Flooding	2.54E-03	0.09%	1.74E-09	6.84E-07
%FLWSMFB	Major Service Water Rupture in the Fuel Building	Flooding	4.24E-05	0.08%	1.67E-09	3.93E-05
%FLFWNMTB	Nominal or Major Feedwater Rupture in Turbine Building	Flooding	3.01E-03	0.08%	1.66E-09	5.52E-07
%FLSXBMAB	Major Shutdown Service Water B Rupture in AB	Flooding	6.40E-05	0.07%	1.34E-09	2.10E-05
%FLSXANSXA	Nominal SX/WS Pipe Rupture in SX A Room	Flooding	1.33E-05	0.05%	1.08E-09	8.14E-05
%TAC8E	Loss of 4 KV Bus 1AP08E	Special	2.02E-03	0.05%	1.08E-09	5.35E-07

Table 2.3.1-1

Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%A-ADS	Inadvertent ADS	LOCA	1.00E-05	0.05%	1.07E-09	1.07E-04
%TDC1E	Loss of DC Bus 1E	Special	4.23E-04	0.05%	1.02E-09	2.41E-06
%S1-LP	Medium LOCA in LPCI Line	LOCA	9.06E-06	0.05%	9.71E-10	1.07E-04
%TDC1F	Loss of DC Bus 1F	Special	4.23E-04	0.05%	9.53E-10	2.25E-06
%FLSXBNCB5A	Nominal SX B Rupture in Div 3 Switchgear room	Flooding	8.23E-05	0.04%	8.86E-10	1.08E-05
%FLFPNCB3A	Nominal FP Rupture in Fire Area CB-3a	Flooding	2.70E-05	0.04%	8.09E-10	3.00E-05
%FLSXAMAB	Major Shutdown Service Water A Rupture in AB	Flooding	4.15E-05	0.04%	7.26E-10	1.75E-05
%TAC06E	Loss of 480 V Bus 0AP06E	Special	5.20E-04	0.03%	6.44E-10	1.24E-06
%A-ST	Large LOCA above TAF (steam LOCA)	LOCA	6.00E-06	0.03%	6.39E-10	1.07E-04
%FLSXANCB5A	Nominal SX A Rupture in Div 3 Switchgear room	Flooding	4.71E-05	0.03%	5.70E-10	1.21E-05
%S1-HP	Medium LOCA in HPCS Line	LOCA	2.42E-06	0.03%	5.27E-10	2.18E-04
%FLWSNHPCS	Nominal Service Water Rupture in HPCS Room	Flooding	5.41E-05	0.03%	5.19E-10	9.59E-06
%S1-CS	Medium LOCA in LPCS Line	LOCA	4.64E-06	0.02%	4.94E-10	1.07E-04
%TAC05E	Loss of 480 V Bus 0AP05E	Special	5.20E-04	0.02%	4.58E-10	8.81E-07
%FLSXCNSXC	Nominal SX/WS Pipe Rupture in SX C Room	Flooding	1.02E-04	0.02%	3.64E-10	3.57E-06
%A-LP	Large LOCA in LPCI Line	LOCA	3.26E-06	0.02%	3.46E-10	1.06E-04
%FLSXAMSXA	Major SX/WS Pipe Rupture in SX A Room	Flooding	4.01E-06	0.02%	3.03E-10	7.55E-05
%FLRHRASNMRHRA	Nominal or Major RHR A Suppression Pool Suction Pipe Rupture	Flooding	1.09E-06	0.01%	2.92E-10	2.68E-04
%BOC-MS	Main Steam Line BOC	LOCA	7.04E-10	0.01%	2.38E-10	3.38E-01
%FLWONM	Nominal or Major Chilled Water rupture	Flooding	4.80E-04	0.01%	1.75E-10	3.66E-07

Table 2.3.1-1

Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%A-WA	Large LOCA below TAF (water LOCA)	LOCA	1.58E-06	0.01%	1.67E-10	1.06E-04
%A-HP	Large LOCA in HPCS Line	LOCA	8.56E-07	0.01%	1.32E-10	1.54E-04
%TRLA	Break in Medium Range RX Water Reference Leg A	Special	6.67E-04	0.01%	1.31E-10	1.97E-07
%TRLB	Break in Medium Range RX water Reference Leg B	Special	6.67E-04	0.01%	1.31E-10	1.97E-07
%FLFPNCB4	Nominal FP Rupture in Fire Area CB-4	Flooding	2.49E-04	0.00%	9.90E-11	3.97E-07
%TSW	Loss of Service Water	Special	1.00E+00	0.00%	9.58E-11	9.58E-11
%FLFPNCB	Nominal Fire Water Rupture in Control Building	Flooding	4.25E-03	0.00%	7.29E-11	1.72E-08
%A-CS	Large LOCA in LPCS Line	LOCA	6.74E-07	0.00%	7.06E-11	1.05E-04
%BOC-RW	RWCU Suction BOC	LOCA	2.01E-10	0.00%	6.75E-11	3.36E-01
%BOC-RC	RCIC Line BOC	LOCA	2.01E-10	0.00%	6.75E-11	3.36E-01
%FLFPMCB	Major Fire Water Rupture in Control Building	Flooding	1.48E-03	0.00%	6.54E-11	4.42E-08
%FLRHRBSNMRHRB	Nominal or Major RHR B Suppression Pool Suction Pipe Rupture	Flooding	2.41E-07	0.00%	4.99E-11	2.07E-04
%FLSXCNCB5A	Nominal SX C Rupture in Div 3 Switchgear room	Flooding	8.23E-05	0.00%	4.90E-11	5.95E-07
%FLSXNHPCS	Nominal SX Rupture in HPCS Room	Flooding	7.97E-05	0.00%	4.74E-11	5.95E-07
%ISLOCA-SDC	ISLOCA - RHR SDC Suction	LOCA	3.84E-11	0.00%	3.59E-11	9.35E-01
%BOC-HP	HPCS BOC	LOCA	1.08E-10	0.00%	3.58E-11	3.32E-01
%FLSXBNCB4	Nominal SX B Rupture in Fire Area CB-4	Flooding	3.23E-05	0.00%	3.55E-11	1.10E-06
%FLSXANCB4	Nominal SX A Rupture in Fire Area CB-4	Flooding	2.55E-05	0.00%	2.84E-11	1.11E-06
%FLCCNM	Nominal or Major Component Cooling rupture	Flooding	7.40E-05	0.00%	2.77E-11	3.74E-07

Table 2.3.1-1

Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%FLSXAMCB	Major SX A Rupture in Control Building	Flooding	8.92E-05	0.00%	2.45E-11	2.74E-07
%FLRISNMRCIC	Nominal or Major RCIC Suppression Pool Suction Pipe Rupture in RCIC Room	Flooding	1.38E-06	0.00%	2.34E-11	1.69E-05
%FLSXBMCB	Major SX B Rupture in Control Building	Flooding	7.69E-05	0.00%	2.11E-11	2.74E-07
%FLFPNCB5	Nominal FP Rupture in Div 3 Switchgear room	Flooding	4.72E-05	0.00%	1.82E-11	3.86E-07
%FLFPNCB2	Nominal FP Rupture in Fire Area CB-2	Flooding	5.39E-05	0.00%	1.40E-11	2.61E-07
%FLRHRCSNMRHRC	Nominal or Major RHR C Suppression Pool Suction Pipe Rupture	Flooding	8.65E-07	0.00%	1.16E-11	1.34E-05
%FLLPSNMLPCS	Nominal or Major LPCS Suppression Pool Suction Pipe Rupture in LPCS Room	Flooding	7.91E-07	0.00%	1.06E-11	1.34E-05
%FLHPCSSNMHPCS	Nominal or Major HPCS Suction Pipe Rupture	Flooding	7.66E-07	0.00%	1.03E-11	1.34E-05
%FLSXBNCB2	Nominal SX B Rupture in Fire Area CB-2	Flooding	4.31E-05	0.00%	8.80E-12	2.04E-07
%FLFWNMTUN	Nominal or Major Feedwater failure in the Main Pipe Tunnel	Flooding	1.23E-05	0.00%	2.90E-12	2.35E-07
%FLSXBNCB	Nominal SX B Rupture in Control Building	Flooding	4.66E-04	0.00%	2.14E-12	4.59E-09
%FLSXANCB	Nominal SX A Rupture in Control Building	Flooding	4.62E-04	0.00%	2.12E-12	4.59E-09
%ISLOCA-LPB	ISLOCA - RHR LPCI Train B	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%ISLOCA-LPC	ISLOCA - RHR LPCI Train C	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%ISLOCA-SDCB	ISLOCA - RHR SDC Return Train B	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%FLWONCB5	Nominal WO Rupture in Div 3 Switchgear room	Flooding	8.03E-06	0.00%	1.15E-12	1.44E-07
%ISLOCA-FW	ISLOCA - FW Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00
%ISLOCA-HP	ISLOCA - HPCS Injection	LOCA	1.00E-12	0.00%	0.00E+00	0.00E+00
%ISLOCA-CS	ISLOCA - LPCS Injection	LOCA	1.25E-12	0.00%	0.00E+00	0.00E+00

Table 2.3.1-1

Clinton FPIE CDF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/crit yr)	%CDF	CDF (/yr)	CCDP
%ISLOCA-LPA	ISLOCA - RHR LPCI Train A	LOCA	1.25E-12	0.00%	0.00E+00	0.00E+00
%ISLOCA-SDCA	ISLOCA - RHR SDC Return Train A	LOCA	1.25E-12	0.00%	0.00E+00	0.00E+00
%BOC-FW	Feedwater Line BOC	LOCA	2.22E-13	0.00%	0.00E+00	0.00E+00
%RAT	Loss of RAT	Special	0.00E+00	0.00%	0.00E+00	-
%INV1A	Turbine Trip Caused By XFMR Failure with Inverter S001A in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%INV1B	Turbine Trip Caused By XFMR Failure with Inverter S001B in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%IV1AMSIV	MSIV Closure due to Div. 1 Inverter S001A in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
			Total CDF (/yr)	**99.99%(1)**	**2.00E-06**	**-**

Note to Table 2.3.1-1:

(1) Rounding error based on importances generated from CAFTA.

Table 2.3.1-2

Clinton FPIE CDF Contribution by Accident Class

Accident Class	Subclass	Description	CDF (/yr)	%CDF
Class I	IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	7.39E-07	37.00%
	IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	1.89E-07	9.45%
	IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	4.20E-07	21.01%
	IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	4.20E-09	0.21%
	ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	1.63E-07	8.19%
	IE	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high and DC power is unavailable. (Grouped with Class IA)	-	-
Class II	II	Accident sequences involving a loss of containment heat removal.	-	-
	IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	2.49E-07	12.45%
	IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	2.73E-10	0.01%
	IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	8.06E-09	0.40%
	IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	3.93E-08	1.97%
	IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-

Table 2.3.1-2

Clinton FPIE CDF Contribution by Accident Class

Accident Class	Subclass	Description	CDF (/yr)	%CDF
Class III	IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	9.56E-10	0.05%
	IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	3.51E-10	0.02%
	IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	1.17E-08	0.59%
	IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	2.08E-09	0.10%
Class IV	IV	Accident sequences involving failure of adequate shutdown reactivity.	1.70E-07	8.53%
	IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
	IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-
	IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
	IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
Class V	V	Unisolated LOCA outside containment.	4.48E-10	0.02%
		Total CDF (/yr)	**2.00E-06**	**100.00%**

Summary of Clinton FPIE Level 2 Release Category Frequencies (1),(2)

yr)	Intact (3),(5)	LL/E	LL/I	LL/L	L/E	L/I	L/L	M/E	M/I	M/L	H/E (4)	H/I	H/L	T
07	6.90E-07	3.38E-10	-	1.97E-08	5.78E-09	-	5.42E-08	2.05E-09	-	5.87E-10	4.92E-09	-	1.29E-08	
07	0.00E+00	1.35E-08	-	-	1.43E-07	-	-	2.48E-08	-	-	2.11E-08	-	-	
07	9.11E-08	-	-	1.38E-08	-	-	8.26E-08	-	-	1.21E-08	-	-	2.49E-07	
09	4.46E-09	-	-	0.00E+00	7.51E-12	-	1.17E-11	-	-	-	9.33E-12	-	0.00E+00	
07	1.20E-07	2.50E-10	-	1.21E-08	8.64E-10	-	3.01E-08	2.30E-09	-	4.26E-10	2.25E-09	-	6.58E-09	
	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	
07	0.00E+00	-	-	-	-	-	-	5.76E-09	-	1.60E-07	4.85E-09	-	1.43E-07	
10	0.00E+00	-	-	-	-	-	-	-	-	6.62E-12	4.77E-12	-	4.79E-10	
09	0.00E+00	-	-	-	-	-	-	2.30E-10	-	7.43E-09	5.34E-11	-	1.63E-09	
08	0.00E+00	-	-	-	-	-	-	1.70E-09	-	4.00E-08	3.47E-11	-	3.21E-09	
	-	-	-	-	-	-	-	-	-	-	-	-	-	
09	1.01E-09	-	-	6.02E-12	3.01E-12	-	0.00E+00	-	-	4.41E-12	8.60E-13	-	0.00E+00	
10	0.00E+00	-	-	6.02E-11	1.32E-10	-	1.07E-10	2.01E-11	-	-	2.74E-11	-	3.75E-11	
08	1.07E-08	1.69E-11	-	6.18E-10	1.10E-10	-	8.37E-10	2.85E-11	-	8.82E-12	3.05E-11	-	1.88E-10	
09	1.45E-10	-	-	-	-	-	-	-	-	-	2.09E-09	-	-	
07	1.42E-08	-	-	-	-	-	-	1.31E-07	-	-	3.73E-08	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	
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	-	-	-	-	-	-	-	-	-	-	-	-	-	
10	2.55E-11	-	-	-	-	-	-	-	-	-	4.54E-10	-	-	
06	**9.32E-07**	**1.41E-08**	**0.00E+00**	**4.63E-08**	**1.50E-07**	**0.00E+00**	**1.68E-07**	**1.68E-07**	**0.00E+00**	**2.21E-07**	**7.31E-08**	**0.00E+00**	**4.17E-07**	

lculated at a truncation limit of 1E-13/yr, which is the base truncation level for LERF.

he accident class does not contribute to the release category.

ntact" column indicates that the difference between CDF and the total release for that accident class is negative (i.e., less than zero) due to the rounding errors generated at the higher truncation limi
do not affect risk insights used in risk applications.

se category represents the LERF results.

alculated as the difference between CDF and the total release frequency for the given accident class.

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%LOOP	Loss of Offsite Power	Transient	2.32E-02	35.00%	2.56E-08	1.10E-06
%TT	Turbine Trip	Transient	2.20E-01	28.95%	2.12E-08	9.62E-08
%TF	Loss of Feedwater	Transient	3.94E-02	4.18%	3.06E-09	7.76E-08
%OPC-RAT	OPC Occurs Upstream of RAT B	Special	2.90E-03	3.95%	2.89E-09	9.95E-07
%TC	Loss of Condenser Vacuum	Transient	3.12E-02	3.10%	2.27E-09	7.27E-08
%CCW	Loss of CCW	Special	1.00E+00	2.53%	1.85E-09	1.85E-09
%FLFPMAB	Major Fire Protection Water Rupture in AB	Flooding	8.89E-04	2.13%	1.56E-09	1.75E-06
%FLFPMMCR	Major FP Rupture Above MCR	Flooding	8.68E-05	1.79%	1.31E-09	1.50E-05
%MS	Manual Shutdown	Transient	1.50E+00	1.69%	1.24E-09	8.24E-10
%TIA	Loss of Instrument Air	Special	1.55E-02	1.63%	1.19E-09	7.69E-08
%R	Excessive LOCA	LOCA	1.00E-08	1.31%	9.57E-10	9.57E-02
%TI	Inadvertent Open Relief Valve	Transient	8.14E-03	1.11%	8.07E-10	9.92E-08
%TBCCW	Loss of TBCCW	Special	1.00E+00	1.00%	7.28E-10	7.28E-10
%TM	MSIV Closure	Transient	9.19E-03	0.88%	6.43E-10	6.99E-08
%OPC-ERAT	OPC Occurs Upstream of ERAT	Special	2.90E-03	0.80%	5.85E-10	2.02E-07
%FLSXBNCB3A	Nominal SX B Rupture in Fire Area CB-3a	Flooding	5.50E-05	0.79%	5.77E-10	1.05E-05
%FLWSMAB	Major Service Water Rupture in AB	Flooding	1.58E-04	0.76%	5.56E-10	3.52E-06
%S1-ST	Medium LOCA above TAF (steam LOCA)	LOCA	4.35E-05	0.66%	4.85E-10	1.12E-05
%FLSXBMCB3A	Major SX B Rupture in Fire Area CB-3a	Flooding	9.24E-06	0.44%	3.20E-10	3.46E-05
%S1-WA	Medium LOCA below TAF (water LOCA)	LOCA	2.79E-05	0.42%	3.10E-10	1.11E-05
%FLWSNMCBTBSH	Nominal or Major Service Water rupture In the Control, Turbine, or Screenhouse buildings	Flooding	3.17E-03	0.39%	2.85E-10	8.98E-08
%FLVCMMCR	Major VC Rupture in CB-1i Above MCR	Flooding	1.89E-05	0.39%	2.82E-10	1.49E-05

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%BOC-MS	Main Steam Line BOC	LOCA	7.04E-10	0.33%	2.40E-10	3.40E-01
%TAC11E	Loss of 480 V Bus 0AP11E	Special	5.20E-04	0.32%	2.32E-10	4.46E-07
%TAC4E	Loss of 6.9 KV Bus 1AP04E	Special	3.12E-03	0.30%	2.22E-10	7.13E-08
%TAC8E	Loss of 4 KV Bus 1AP08E	Special	2.02E-03	0.30%	2.20E-10	1.09E-07
%TAC5E	Loss of 6.9 KV Bus 1AP05E	Special	3.12E-03	0.29%	2.10E-10	6.74E-08
%FLFWNMTB	Nominal or Major Feedwater Rupture in Turbine Building	Flooding	3.01E-03	0.28%	2.01E-10	6.68E-08
%FLSXBMMCR	Major SX B Rupture Above MCR	Flooding	1.26E-05	0.26%	1.88E-10	1.49E-05
%FLSXAMMCR	Major SX A Rupture Above MCR	Flooding	1.26E-05	0.26%	1.87E-10	1.48E-05
%TAC12E	Loss of 480 V Bus 0AP12E	Special	5.20E-04	0.26%	1.87E-10	3.59E-07
%TDC1E	Loss of DC Bus 1E	Special	4.23E-04	0.24%	1.73E-10	4.09E-07
%TDC1F	Loss of DC Bus 1F	Special	4.23E-04	0.24%	1.73E-10	4.09E-07
%FLCWNM	Nominal or Major Circulating Water Rupture in Turbine Building or Screenhouse	Flooding	2.54E-03	0.24%	1.73E-10	6.80E-08
%FLWSMFB	Major Service Water Rupture in the Fuel Building	Flooding	4.24E-05	0.23%	1.70E-10	4.00E-06
%FLSXBNSXB	Nominal SX/WS Pipe Rupture in SX B Room	Flooding	1.26E-04	0.23%	1.67E-10	1.33E-06
%FLSXBMAB	Major Shutdown Service Water B Rupture in AB	Flooding	6.40E-05	0.20%	1.44E-10	2.25E-06
%S2-WA	Small LOCA (Below TAF)	LOCA	1.59E-04	0.20%	1.43E-10	8.99E-07
%TAC6E	Loss of 4 KV Bus 1AP06E	Special	2.02E-03	0.19%	1.39E-10	6.89E-08
%FLSXBMSXB	Major SX/WS Pipe Rupture in SX B Room	Flooding	2.09E-05	0.17%	1.26E-10	6.05E-06
%A-ADS	Inadvertent ADS	LOCA	1.00E-05	0.15%	1.10E-10	1.10E-05
%S1-LP	Medium LOCA in LPCI Line	LOCA	9.06E-06	0.14%	9.97E-11	1.10E-05

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%S2-ST	Small LOCA (Above TAF)	LOCA	1.63E-04	0.10%	7.24E-11	4.44E-07
%BOC-RW	RWCU Suction BOC	LOCA	2.01E-10	0.09%	6.81E-11	3.39E-01
%BOC-RC	RCIC Line BOC	LOCA	2.01E-10	0.09%	6.81E-11	3.39E-01
%A-ST	Large LOCA above TAF (steam LOCA)	LOCA	6.00E-06	0.09%	6.56E-11	1.09E-05
%FLSXAMAB	Major Shutdown Service Water A Rupture in AB	Flooding	4.15E-05	0.08%	5.65E-11	1.36E-06
%S1-CS	Medium LOCA in LPCS Line	LOCA	4.64E-06	0.07%	5.07E-11	1.09E-05
%FLSXBNCB5A	Nominal SX B Rupture in Div 3 Switchgear room	Flooding	8.23E-05	0.06%	4.08E-11	4.95E-07
%BOC-HP	HPCS BOC	LOCA	1.08E-10	0.05%	3.66E-11	3.39E-01
%ISLOCA-SDC	ISLOCA - RHR SDC Suction	LOCA	3.84E-11	0.05%	3.59E-11	9.35E-01
%TAC06E	Loss of 480 V Bus 0AP06E	Special	5.20E-04	0.05%	3.56E-11	6.84E-08
%A-LP	Large LOCA in LPCI Line	LOCA	3.26E-06	0.05%	3.54E-11	1.09E-05
%TAC05E	Loss of 480 V Bus 0AP05E	Special	5.20E-04	0.05%	3.40E-11	6.53E-08
%S1-HP	Medium LOCA in HPCS Line	LOCA	2.42E-06	0.04%	3.13E-11	1.29E-05
%FLWONM	Nominal or Major Chilled Water rupture	Flooding	4.80E-04	0.04%	2.96E-11	6.17E-08
%TRLA	Break in Medium Range RX Water Reference Leg A	Special	6.67E-04	0.04%	2.63E-11	3.95E-08
%TRLB	Break in Medium Range RX water Reference Leg B	Special	6.67E-04	0.04%	2.63E-11	3.95E-08
%FLWSMHPCS	Major Service Water Rupture in HPCS Room	Flooding	1.60E-05	0.04%	2.60E-11	1.63E-06
%FLSXANCB5A	Nominal SX A Rupture in Div 3 Switchgear room	Flooding	4.71E-05	0.03%	2.34E-11	4.96E-07
%FLFPNCB3A	Nominal FP Rupture in Fire Area CB-3a	Flooding	2.70E-05	0.03%	2.25E-11	8.33E-07

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%FLFPNCB4	Nominal FP Rupture in Fire Area CB-4	Flooding	2.49E-04	0.03%	1.83E-11	7.37E-08
%A-WA	Large LOCA below TAF (water LOCA)	LOCA	1.58E-06	0.02%	1.69E-11	1.07E-05
%TSW	Loss of Service Water	Special	1.00E+00	0.02%	1.47E-11	1.47E-11
%FLSXCNSXC	Nominal SX/WS Pipe Rupture in SX C Room	Flooding	1.02E-04	0.02%	1.39E-11	1.36E-07
%FLFPNCB	Nominal Fire Water Rupture in Control Building	Flooding	4.25E-03	0.02%	1.20E-11	2.82E-09
%FLSXANSXA	Nominal SX/WS Pipe Rupture in SX A Room	Flooding	1.33E-05	0.02%	1.14E-11	8.58E-07
%A-HP	Large LOCA in HPCS Line	LOCA	8.56E-07	0.01%	9.84E-12	1.15E-05
%A-CS	Large LOCA in LPCS Line	LOCA	6.74E-07	0.01%	7.17E-12	1.06E-05
%FLSXCNCB5A	Nominal SX C Rupture in Div 3 Switchgear room	Flooding	8.23E-05	0.01%	6.81E-12	8.28E-08
%FLSXNHPCS	Nominal SX Rupture in HPCS Room	Flooding	7.97E-05	0.01%	6.60E-12	8.28E-08
%FLFPMCB	Major Fire Water Rupture in Control Building	Flooding	1.48E-03	0.01%	6.48E-12	4.38E-09
%FLWSNHPCS	Nominal Service Water Rupture in HPCS Room	Flooding	5.41E-05	0.01%	6.40E-12	1.18E-07
%FLSXAMCB	Major SX A Rupture in Control Building	Flooding	8.92E-05	0.01%	4.86E-12	5.45E-08
%FLSXBMCB	Major SX B Rupture in Control Building	Flooding	7.69E-05	0.01%	4.10E-12	5.34E-08
%FLSXBNCB4	Nominal SX B Rupture in Fire Area CB-4	Flooding	3.23E-05	0.01%	3.97E-12	1.23E-07
%FLCCNM	Nominal or Major Component Cooling rupture	Flooding	7.40E-05	0.01%	3.95E-12	5.34E-08
%FLFPNCB5	Nominal FP Rupture in Div 3 Switchgear room	Flooding	4.72E-05	0.00%	3.47E-12	7.36E-08
%FLSXAMSXA	Major SX/WS Pipe Rupture in SX A Room	Flooding	4.01E-06	0.00%	2.93E-12	7.31E-07

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%FLFPNCB2	Nominal FP Rupture in Fire Area CB-2	Flooding	5.39E-05	0.00%	2.91E-12	5.40E-08
%FLSXANCB4	Nominal SX A Rupture in Fire Area CB-4	Flooding	2.55E-05	0.00%	2.71E-12	1.06E-07
%FLSXBNCB2	Nominal SX B Rupture in Fire Area CB-2	Flooding	4.31E-05	0.00%	2.24E-12	5.20E-08
%ISLOCA-LPB	ISLOCA - RHR LPCI Train B	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%ISLOCA-LPC	ISLOCA - RHR LPCI Train C	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%ISLOCA-SDCB	ISLOCA - RHR SDC Return Train B	LOCA	1.25E-12	0.00%	1.17E-12	9.35E-01
%FLRHRASNMRHRA	Nominal or Major RHR A Suppression Pool Suction Pipe Rupture	Flooding	1.09E-06	0.00%	8.88E-13	8.15E-07
%FLFWNMTUN	Nominal or Major Feedwater failure in the Main Pipe Tunnel	Flooding	1.23E-05	0.00%	5.15E-13	4.19E-08
%ISLOCA-CS	ISLOCA - LPCS Injection	LOCA	1.25E-12	0.00%	4.15E-13	3.32E-01
%ISLOCA-LPA	ISLOCA - RHR LPCI Train A	LOCA	1.25E-12	0.00%	4.15E-13	3.32E-01
%ISLOCA-SDCA	ISLOCA - RHR SDC Return Train A	LOCA	1.25E-12	0.00%	4.15E-13	3.32E-01
%FLSXBNCB	Nominal SX B Rupture in Control Building	Flooding	4.66E-04	0.00%	3.81E-13	8.18E-10
%FLSXANCB	Nominal SX A Rupture in Control Building	Flooding	4.62E-04	0.00%	3.78E-13	8.18E-10
%FLWONCB5	Nominal WO Rupture in Div 3 Switchgear room	Flooding	8.03E-06	0.00%	3.37E-13	4.19E-08
%ISLOCA-FW	ISLOCA - FW Injection	LOCA	1.00E-12	0.00%	3.32E-13	3.32E-01
%ISLOCA-HP	ISLOCA - HPCS Injection	LOCA	1.00E-12	0.00%	3.32E-13	3.32E-01
%FLRHRBSNMRHRB	Nominal or Major RHR B Suppression Pool Suction Pipe Rupture	Flooding	2.41E-07	0.00%	0.00E+00	0.00E+00
%FLRISNMRCIC	Nominal or Major RCIC Suppression Pool Suction Pipe Rupture in RCIC Room	Flooding	1.38E-06	0.00%	0.00E+00	0.00E+00
%BOC-FW	Feedwater Line BOC	LOCA	2.22E-13	0.00%	0.00E+00	0.00E+00

Table 2.3.2-2

Clinton FPIE LERF Contribution by Initiating Event

Initiating Event	Description	IE Category	IE Frequency (/yr)	%LERF	LERF (/yr)	CLERP
%FLRHRCSNMRHRC	Nominal or Major RHR C Suppression Pool Suction Pipe Rupture	Flooding	8.65E-07	0.00%	0.00E+00	0.00E+00
%FLLPSNMLPCS	Nominal or Major LPCS Suppression Pool Suction Pipe Rupture in LPCS Room	Flooding	7.91E-07	0.00%	0.00E+00	0.00E+00
%FLHPCSSNMHPCS	Nominal or Major HPCS Suction Pipe Rupture	Flooding	7.66E-07	0.00%	0.00E+00	0.00E+00
%RAT	Loss of RAT	Special	0.00E+00	0.00%	0.00E+00	-
%INV1A	Turbine Trip Caused By XFMR Failure with Inverter S001A in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%INV1B	Turbine Trip Caused By XFMR Failure with Inverter S001B in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%IV1AMSIV	MSIV Closure due to Div. 1 Inverter S001A in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%IV1BMSIV	MSIV Closure due to Div. 2 Inverter S001B in Maintenance	Special	1.00E+00	0.00%	0.00E+00	0.00E+00
%FLCCMAB	Major Component Cooling rupture in area above RHR B/C in Aux Building	Flooding	2.65E-07	0.00%	0.00E+00	0.00E+00
%FLRISMHPCS	Major RCIC Suction Rupture in HPCS Room	Flooding	9.03E-08	0.00%	0.00E+00	0.00E+00
%FLRISNHPCS	Nominal RCIC Suction Rupture in HPCS Room	Flooding	4.04E-07	0.00%	0.00E+00	0.00E+00
%FLSXMCDB	Major SX Pipe Rupture in Control/Diesel Area	Flooding	2.17E-05	0.00%	0.00E+00	0.00E+00
		Total LERF (/yr)	**-**	**100.00%**	**7.31E-08**	**-**

Table 2.3.2-3

Clinton FPIE LERF Contribution by Accident Class

Accident Class	Subclass	Description	LERF (/yr)	%LERF
Class I	IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	4.92E-09	6.73%
	IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	2.11E-08	28.87%
	IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	-	-
	IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	9.33E-12	0.01%
	ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	2.25E-09	3.08%
	IE	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high and DC power is unavailable. (Grouped with Class IA)	-	-
Class II	II	Accident sequences involving a loss of containment heat removal.	-	-
	IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	4.85E-09	6.63%
	IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	4.77E-12	0.01%
	IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	5.34E-11	0.07%
	IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	3.47E-11	0.05%
	IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-

Table 2.3.2-3

Clinton FPIE LERF Contribution by Accident Class

Accident Class	Subclass	Description	LERF (/yr)	%LERF
Class III	IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	8.60E-13	0.00%
	IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	2.74E-11	0.04%
	IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	3.05E-11	0.04%
	IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	2.09E-09	2.85%
Class IV	IV	Accident sequences involving failure of adequate shutdown reactivity.	3.73E-08	50.98%
	IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
	IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-
	IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
	IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
Class V	V	Unisolated LOCA outside containment.	4.54E-10	0.62%
		Total LERF (/yr)	**7.31E-08**	**100.00%**

Table 2.4.1-1

Clinton Fire CDF by PAU

PAU	Description	CDF (/yr)	%CDF
A-2n	Division 1 Switchgear Room - elevation 781'-0"	9.67E-06	30.96%
A-2k	Nonsafety Switchgear Room (East) - elevation 762'-0"	7.50E-06	24.03%
CB-5a	Division 3 Switchgear Room - elevation 781'-0"	2.24E-06	7.18%
A-3f	Division 2 Switchgear Room - elevation 781'-0"	1.85E-06	5.92%
CB-3a	Auxiliary Electric Equipment Room - elevation 781'-0"	1.60E-06	5.13%
CB-6a	Main Control Room Complex - elevation 800'-0"	1.57E-06	5.02%
D-4a	Division 3 Diesel-Generator Room - elevation 737'-0"	1.53E-06	4.91%
A-3d	Nonsafety Switchgear Room (West) - elevation 762'-0"	1.39E-06	4.46%
A-2o	Containment Electrical Penetration (East) area - elevation 781'-0"	6.80E-07	2.18%
D-6a	Division 2 Diesel-Generator Room - elevation 737'-0"	5.87E-07	1.88%
TY-1a	RAT Areas	5.53E-07	1.77%
D-5a	Division 1 Diesel-Generator Room - elevation 737'-0"	3.74E-07	1.20%
Other	All other PAUs	1.67E-06	5.35%
	Total CDF (/yr)	**3.12E-05**	**100.00%**

Table 2.4.1-2

Clinton Fire CDF by Fire Scenario

Scenario	Description	CDF (/yr)	%CDF
%F_A-2K_1AP06E_H_Y2	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 2	2.92E-06	9.35%
%F_A-2N_1AP07E_E_G	Fire at 4.16kV MVSG 1AP07E (non-HEAF) - FIS Only	2.39E-06	7.64%
%F_A-2K_1AP06E_H_O	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	2.18E-06	6.97%
%F_CB-5A_1E22-S004_H_O	Fire at 4.16kV MVSG 1E22-S004 (HEAF) - Beyond ZOI	2.00E-06	6.40%
%F_A-2N_1AP07E_H_Y	Fire at 4.16kV MVSG 1AP07E (HEAF) - ZOI	1.90E-06	6.09%
%F_D-4A_ALL_A_W	Full Room Burnout - Division 3 Diesel-Generator Room	1.49E-06	4.78%
%F_A-2N_1AP07E_H_O	Fire at 4.16kV MVSG 1AP07E (HEAF) - Beyond ZOI	1.38E-06	4.41%
%F_A-2K_1AP04E_H_O	Fire at 6.9kV MVSG 1AP04E (HEAF) - Beyond ZOI	1.32E-06	4.24%
%F_A-3D_1AP08E_H_Y	Fire at 4.16kV MVSG 1AP08E (HEAF) - ZOI	1.11E-06	3.54%
%F_A-3F_1AP09E_H_O	Fire at 4.16kV MVSG 1AP09E (HEAF) - Beyond ZOI	7.24E-07	2.32%
%F_A-2O_ALL_A_W	Full Room Burnout - Containment Electrical Penetration (East) area	6.80E-07	2.18%
%F_CB-3A_1DC17E_E_Y	Fire at MCC 1DC17E - ZOI	6.18E-07	1.98%
%F_A-2N_1AP73E_E_Y	Fire at MCC 1AP73E - ZOI	5.82E-07	1.87%
%F_A-2N_1AP74E_E_Y	Fire at MCC 1AP74E - ZOI	5.82E-07	1.87%
%F_A-2N_1DC13E_E_Y	Fire at MCC 1DC13E - ZOI	5.82E-07	1.87%
%F_TY-1A_ALL_A_W	Full Room Burnout - RAT Areas	5.53E-07	1.77%
%F_A-2N_1AP72E_E_Y	Fire at MCC 1AP72E - ZOI	4.58E-07	1.47%
%F_A-2N_1AP93E_E_Y	Fire at MCC 1AP93E - ZOI	4.58E-07	1.47%
%F_A-2N_1AP07E_E_Y	Fire at 4.16kV MVSG 1AP07E (non-HEAF) - ZOI	4.56E-07	1.46%
%F_A-3F_1AP09E_E_G	Fire at 4.16kV MVSG 1AP09E (non-HEAF) - FIS Only	4.23E-07	1.36%
%F_CB-3A_1PL90J_E_G	Fire at EP 1PL90J - FIS Only	4.13E-07	1.32%
%F_A-3F_1AP09E_H_Y	Fire at 4.16kV MVSG 1AP09E (HEAF) - ZOI	3.92E-07	1.26%
%F_CB-6A_ALL_E_A	Fire at non-MCB EPs - MCR Abandonment	3.46E-07	1.11%
%F_A-2K_1AP06E_H_Y1	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 1	3.37E-07	1.08%

Table 2.4.1-2

Clinton Fire CDF by Fire Scenario

Scenario	Description	CDF (/yr)	%CDF
Other	All other fire scenarios	6.94E-06	22.22%
	Total CDF (/yr)	**3.12E-05**	**100.00%**

Table 2.4.1-3

Clinton Fire CDF by Accident Class

Subclass	Description	CDF (/yr)	%CDF
IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	3.21E-06	10.29%
IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	6.37E-06	20.42%
IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	1.77E-06	5.66%
IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	1.07E-09	0.00%
ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	2.40E-07	0.77%
II	Accident sequences involving a loss of containment heat removal.	-	-
IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	1.71E-05	54.65%
IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	7.26E-07	2.33%
IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	1.23E-06	3.93%
IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	4.05E-07	1.30%
IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-
IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	-	-
IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	5.42E-08	0.17%
IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	1.09E-07	0.35%

Table 2.4.1-3

Clinton Fire CDF by Accident Class

Subclass	Description	CDF (/yr)	%CDF
IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	4.95E-09	0.02%
IV	Accident sequences involving failure of adequate shutdown reactivity.	9.95E-08	0.32%
IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g., LOCA or SORV); core damage induced post containment failure.	-	-
IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
V	Unisolated LOCA outside containment.	-	-
	Total CDF (/yr)	**3.13E-05**[(1)]	**100.20%**[(1)]

Note to Table 2.4.1-3:

(1) The total %CDF contribution for all accident class basic events (RCVCL-*) is greater than 100% due to overlap in cutsets from the MCUB summation quantification process. The purpose of this table is to show the relative importance of the different accident classes, rather than to express the numerical importance of the different classes.

Table 2.4.2-1

Clinton Fire LERF by PAU

PAU	Description	LERF (/yr)	%LERF
A-2k	Nonsafety Switchgear Room (East) - elevation 762'-0"	4.60E-07	19.17%
A-2n	Division 1 Switchgear Room - elevation 781'-0"	3.99E-07	16.62%
CB-3a	Auxiliary Electric Equipment Room - elevation 781'-0"	3.70E-07	15.42%
A-3d	Nonsafety Switchgear Room (West) - elevation 762'-0"	2.43E-07	10.10%
CB-5a	Division 3 Switchgear Room - elevation 781'-0"	2.09E-07	8.69%
A-3f	Division 2 Switchgear Room - elevation 781'-0"	1.88E-07	7.84%
D-4a	Division 3 Diesel-Generator Room - elevation 737'-0"	1.42E-07	5.92%
CB-6a	Main Control Room Complex - elevation 800'-0"	9.00E-08	3.75%
A-2o	Containment Electrical Penetration (East) area - elevation 781'-0"	4.10E-08	1.71%
T-1h	General Access and Equipment - elevation 762'-0", 785'-0"	3.15E-08	1.31%
CB-2	Division 2 Cable Spreading room - elevation 781'-0"	2.77E-08	1.15%
TY-1a	RAT Areas	2.63E-08	1.09%
D-5a	Division 1 Diesel-Generator Room - elevation 737'-0"	2.61E-08	1.09%
D-6a	Division 2 Diesel-Generator Room - elevation 737'-0"	2.48E-08	1.03%
Other	All other PAUs	1.23E-07	5.11%
	Total LERF (/yr)	**2.40E-06**	**100.00%**

Table 2.4.2-2

Clinton Fire LERF by Fire Scenario

Scenario	Description	LERF (/yr)	%LERF
%F_CB-3A_1DC17E_E_Y	Fire at MCC 1DC17E - ZOI	2.23E-07	9.30%
%F_A-3D_1AP08E_H_Y	Fire at 4.16kV MVSG 1AP08E (HEAF) - ZOI	1.94E-07	8.06%
%F_CB-5A_1E22-S004_H_O	Fire at 4.16kV MVSG 1E22-S004 (HEAF) - Beyond ZOI	1.89E-07	7.87%
%F_A-2K_1AP06E_H_Y2	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 2	1.70E-07	7.08%
%F_D-4A_ALL_A_W	Full Room Burnout - Division 3 Diesel-Generator Room	1.38E-07	5.74%
%F_A-2N_1AP07E_H_O	Fire at 4.16kV MVSG 1AP07E (HEAF) - Beyond ZOI	1.30E-07	5.40%
%F_A-2K_1AP06E_H_O	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	1.26E-07	5.25%
%F_A-2N_1AP07E_E_G	Fire at 4.16kV MVSG 1AP07E (non-HEAF) - FIS Only	1.12E-07	4.68%
%F_A-3F_1AP09E_H_O	Fire at 4.16kV MVSG 1AP09E (HEAF) - Beyond ZOI	9.11E-08	3.79%
%F_A-2K_1AP04E_H_O	Fire at 6.9kV MVSG 1AP04E (HEAF) - Beyond ZOI	7.54E-08	3.14%
%F_A-3F_1AP09E_H_Y	Fire at 4.16kV MVSG 1AP09E (HEAF) - ZOI	5.93E-08	2.47%
%F_A-2N_1AP07E_H_Y	Fire at 4.16kV MVSG 1AP07E (HEAF) - ZOI	5.77E-08	2.40%
%F_A-3D_1AP08E_H_O	Fire at 4.16kV MVSG 1AP08E (HEAF) - Beyond ZOI	4.34E-08	1.81%
%F_A-2O_ALL_A_W	Full Room Burnout - Containment Electrical Penetration (East) area	4.10E-08	1.71%
%F_CB-3A_1PL90J_E_G	Fire at EP 1PL90J - FIS Only	4.05E-08	1.69%
%F_CB-3A_1PA06J_E_Y	Fire at EP 1PA06J - ZOI	3.60E-08	1.50%
%F_A-2K_1AP06E_H_Y1	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 1	3.24E-08	1.35%
%F_A-2K_1AP04E_H_Y	Fire at 6.9kV MVSG 1AP04E (HEAF) - ZOI	2.90E-08	1.21%
%F_TY-1A_ALL_A_W	Full Room Burnout - RAT Areas	2.63E-08	1.09%
Other	All other fire scenarios	5.88E-07	24.48%
	Total LERF (/yr)	**2.40E-06**	**100.00%**

Table 2.4.2-3

Clinton Fire LERF by Accident Class

Subclass	Description	LERF (/yr)	%LERF
IA	Accident sequences involving loss of inventory makeup in which the reactor pressure remains high.	9.25E-07	38.50%
IBE	Accident sequences involving a station blackout and loss of coolant inventory makeup (Early: < 4 hours).	7.62E-07	31.73%
IBL	Accident sequences involving a station blackout and loss of coolant inventory makeup (Late: > 4 hours).	-	-
IC	Accident sequences involving a loss of coolant inventory induced by an ATWS sequence with containment intact.	-	-
ID	Accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup.	8.42E-10	0.04%
II	Accident sequences involving a loss of containment heat removal.	-	-
IIA	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post containment failure.	5.47E-07	22.77%
IIL	Accident sequences involving a loss of containment heat removal with the RPV breached but no initial core damage; core damage induced post containment failure.	2.81E-08	1.17%
IIT	Accident sequences involving a loss of containment heat removal with the RPV initially intact; core damage induced post high containment pressure.	1.35E-08	0.56%
IIV	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact.	7.32E-09	0.30%
IIVE	Class IIA and III except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact (Early: < 4 hours)	-	-
IIIA	Accident sequences leading to core damage conditions initiated by vessel rupture where the containment integrity is not breached in the initial time phase of the accident.	-	-
IIIB	Accident sequences initiated or resulting in small or medium LOCAs for which the reactor cannot be depressurized prior to core damage occurring.	4.91E-08	2.05%
IIIC	Accident sequences initiated or resulting in medium or large LOCAs for which the reactor is a low pressure and no effective injection is available.	1.43E-08	0.60%

Table 2.4.2-3

Clinton Fire LERF by Accident Class

Subclass	Description	LERF (/yr)	%LERF
IIID	Accident sequences which are initiated by a LOCA or RPV failure and for which the vapor suppression system is inadequate, challenging the containment integrity with subsequent failure of makeup systems.	5.44E-09	0.23%
IV	Accident sequences involving failure of adequate shutdown reactivity.	5.14E-08	2.14%
IVA	Accident sequences involving failure of adequate shutdown reactivity with the RPV initially intact; core damage induced post containment failure.	-	-
IVL	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV); core damage induced post containment failure.	-	-
IVT	Accident sequences involving a failure of adequate shutdown reactivity with the RPV initially intact, core damage induced post high containment pressure. (Not used)	-	-
IVV	Class IVA or IVL except that the vent operates as designed; loss of makeup occurs at some time following vent initiation. Suppression pool saturated but intact. (Not used)	-	-
V	Unisolated LOCA outside containment.	9.44E-11	0.00%
	Total LERF (/yr)	**2.40E-06[1]**	**100.08%[1]**

Note to Table 2.4.2-3:

(1) The total %CDF contribution for all accident class basic events (RCVCL-*) is greater than 100% due to overlap in cutsets from the MCUB summation quantification process. The purpose of this table is to show the relative importance of the different accident classes, rather than to express the numerical importance of the different classes.

Clinton FPIE / Internal Flooding PRA Peer Review Open Facts and Observations (Post F&O Closure)

Details	Basis for Significance	Possible Resolution	Status	Disposition from F&O Closure Review	Maintenance vs. Upgrade	Imp
A-004 Section 5.2 es the use of g values used for order to identify with dependent However, only twelve ver 100 basic events g post-initiator actions are listed in 2-1 as using g values to identify ency. Of these, six alue of 1.0E-02 and s a value of 1.0E-03. aining five use a 0.1. It appears that Hoes are quantified r nominal values. uch low probability s likely to result in ations of dependent eing omitted by on values. Use of a tly high value for required by SR QU- not using a tly high value would an inadequate nent of dependent O originated from G7)	An inadequate process to identify combinations of operator actions can result in significantly underestimating CDF and LERF.	Solve with all post-initiator HEPs set to 1.0 and identify all combinations of operator action-related HEPs. Perform dependency analyses for all combinations.	Partially Resolved	<u>Clinton Assessment:</u> Section 5.3 and Appendix K of the Human Reliability Analysis Notebook (CL-PRA-004) (Reference 13) summarizes HRA Dependency Analysis methodology and results. For CDF and LERF, the FPIE model was quantified with all post-initiator HEPs set to 0.1 or higher at the truncation levels of 5E-9/yr (CDF) and 5E-10/yr (LERF). These truncation levels were selected because they capture all risk-significant post-initiator operator actions. Using the HRA Calculator Dependency Module, all dependent combinations were reviewed for proper dependency levels and order. Once reviewed, a floor value of 1E-06 or 5E-07 may be imposed on the dependent joint HEP depending on the timing of the operator actions. The final FPIE model quantification uses the 0.1 or higher seed values for all post-initiator HEPs and the adjusted dependent joint HEP is recovered using a post-processing recovery file. <u>Independent Review Team Assessment:</u> A check of the CAFTA RR Database indicates that the post-initiator HEPs were set to 0.1 (or greater) prior to dependency analysis. The value of 0.1 can be acceptable depending upon what truncation level is used for the dependency analysis and whether all multiple independent HFEs are recovered by combination HFEs and Joint HEPs. The resolution of this Finding is correlated to Finding 1-34.	<u>Clinton Assessment:</u> Maintenance: Methodology and tools consistent with previous PRA updates. <u>Independent Review Team Assessment:</u> Since no new methods were applied and existing methods were not applied in a different context, this constitutes model maintenance.	This analy depe curre A rev perfo comb depe depe unalt comb unan relate late) be as time- impa legiti ident incre grou overa Furth level is rec Ther docu
the PRA models he HEPs at nominal lt in cutsets with operator actions uncated out or with bined probability of ator actions much e 1E-6 or 5E-7 floor HRA notebook says The peer review antified the PRA ith post-initiator et to 0.1 and d a significant of cutsets containing ations of basic epresenting operator ailure. These ations were reviewed rge number of ations identified in ew were not in the CPS HRA ency evaluation. O originated from G7)	The solution method used likely under predicts the risk values. This under prediction could be significant based on the total number of operator actions included in the CPS model.	Solve the PRA model with operator action failure probability values set to a high value.	Open	<u>Clinton Assessment:</u> See discussion for F&O 1-32. <u>Independent Review Team Assessment:</u> The CL-PRA-004 Rev. 6 document was reviewed. The final model cutsets were re-imported into the existing HRA DAF files (for FPIE CDF only), using a copy of the HRAC database with all 1.0 HEPs removed and the inhibit ADS also removed per the analyst notes for that HFE. This process was used to determine if there are combinations of HFEs occurring in the final results with all HEPs set to nominal values and no combination event applied. 318 new combinations were identified (in addition to the 216 that were originally identified and implemented), several of which had FV values above 5E-03 as calculated by the HRAC (which is not a true risk metric but a good approximation). For example, 1FWOPFLWCTRL-H-- and 1FWOPMANINIT-H-- appear as a combination together and have a dependency level of HD, confirmed in the HRA Calculator via override notes, however when this pair of HFEs appears together it is not recovered with a combination event. This combination has a an FV value of 2.9E-01 as calculated by the HRAC (again, not a true risk metric but a good approximation). This suggests it is likely risk significant when dependencies are accounted for, and additional unanalyzed combinations may also be present when dependencies are accounted for. The review teams concern is that potentially risk significant combinations of HFEs are not captured through the current approach, due to the chosen truncation level for the dependency identification (5E-9 / 5E-10 for CDF/LERF) in conjunction with the elevated HEP level chosen (0.1). This could under predict risk results as stated in the original F&O, and is supported by the observations noted above. It is noted that the example combination above did appear in the 1E-9 / 5E-11 identification cutsets that were included in the dependency files, but not used.	<u>Clinton Assessment:</u> Maintenance: Methodology and tools consistent with previous PRA updates. <u>Independent Review Team Assessment:</u> Maintenance - modeling error, approach will not change.	See

Details	Basis for Significance	Possible Resolution	Status	Disposition from F&O Closure Review	Maintenance vs. Upgrade	Imp
				Recommendations Show that risk significant combinations of HFEs appearing in the final results are all captured in the dependency analysis. Some suggestions on how to accomplish this are provided below. 1) Include more cutsets in the dependency identification process when imported into the HRAC. The total number of cutsets generated for the dependency analysis was low (5596 / 1014) which is likely the leading cause of this issue. The final model maintained the elevated HEP values for all HFEs, suggesting model quantification time is not an issue preventing the generation of additional cutsets through lowering of the identification truncation or increasing the HEP values above 0.1. This can be accomplished by either lowering the identification truncation levels, increasing the elevated HEP values, or both. The balance between these driving factors is model specific and may require some iteration. If this approach is chosen all identified combinations can be implemented if the model allows it, however a more refined approach can be accomplished by using risk metric cutoffs to select which combinations to implement, the use of optimized seed values, or both. 2) Show that the current set of combinations captures all risk significant combinations of HFEs when dependencies are accounted for through a sensitivity study on the final results. Using the final cutsets identify the unanalyzed combinations, and create additional recovery rules for them, using the conservative dependency levels automatically generated by the HRAC or refining as necessary. **Suggestion** For fire this issue may also exist, as the same identification truncation levels were used, and only 21237 / 11552 cutsets were generated. After re importing the final result cutsets for Fire CDF (using an HRAC file with the 1.0s removed), 78 additional combinations were identified, of which several had FV values above 5E-03 as calculated by the HRAC. Therefore, it is suggested that the Fire dependency analysis should be revisited in a similar manner.		

Clinton Fire PRA Peer Review Open Facts and Observations (Post F&O Closure)

etails	Basis for Significance	Possible Resolution	Status	Disposition from F&O Closure Review	Maintenance Upgrade
raceways (ToEvent) in FRANX zone ay have a to type of 1. In response stion, it was indicated that they are ents. However, some of the IDs ow as component in the component le instead they show as raceway in way to cable table. For example, 3. In follow up question, it was d that only PRA-credited components d in the component to BE table and d points are listed in the raceway to le. Those cables terminating in end ith a to type of 1 in zone to raceway eing failed in the model.	Targets with the incorrect TOTYPE code are not reflected in the quantification and the resulting risk may be underestimated.	Perform an extent of condition for the identified error and ensure that all cable terminations are being reflected in the quantification by adding the cable end points with the correct to type in the FRANX zone to raceway table.	Open	N/A – This F&O has not been reviewed through an F&O closure process.	Maintenance Methodology an consistent with p PRA updates.

Table 3-1
Detailed Release Category Frequencies

Release Category	FPIE Freq (/yr)	Fire Freq (/yr)	Total Freq (/yr)	%Contribution
ST1 - BOC	4.48E-10	0.00E+00	4.48E-10	0.00%
ST2 - H/E	5.86E-08	8.15E-07	8.74E-07	2.63%
ST3 - H/L	3.16E-07	1.23E-05	1.26E-05	37.97%
ST4 - M/E	1.52E-07	4.31E-06	4.46E-06	13.44%
ST5 - M/L	1.29E-07	3.45E-06	3.58E-06	10.79%
ST6 - L/E	1.31E-07	3.09E-06	3.22E-06	9.70%
ST7 - L/L	1.40E-07	4.02E-07	5.41E-07	1.63%
ST8 - LL/E	9.79E-09	1.64E-07	1.74E-07	0.52%
ST9 - LL/L	4.18E-08	5.23E-07	5.65E-07	1.70%
ST10 - INTACT	1.02E-06	6.16E-06	7.18E-06	21.62%
Total	**2.00E-06**	**3.12E-05**	**3.32E-05**	0.00%

Note to Table 3-1:

(1) Full power internal events (FPIE) frequency includes the contribution from internal flooding events

Table 5-1a

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
%LOOP	2.32E-02	3.79E-01	LOSS OF OFFSITE POWER INITIATOR	There are a diverse set of contributors to Loss of Offsite Power scenarios for CPS. Top contributors include failure of the additional small containment vent paths to provide adequate pressure relief (17.6%), failure of the primary FLEX pump to run (16.5%) and alt pump (13.1%), DC load shedding failure (16.2%), failure of the EDGs (17% for independent start and run failures and 34% for CCF), and failure to recover DHR in the long term (14.0%). Potential plant enhancements to address these issues include: 1) Installing a FLEX-like hardened containment vent that is simple to operate and does not rely on support systems (SAMA 4), 2) protect the RCIC storage tank to support its use in ELAP scenarios and enhance the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3), 3) Include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2), 3) Install a swing diesel generator that can be aligned to any division and can support the loads required for safe shutdown (SAMA 20). Failure to recover DHR is a data-based event and no specific SAMAs directly related to that event are proposed.
RCVCL-1A	1.00E+00	3.70E-01	ACCIDENT CLASS IA	This is the accident class IA flag. MCR flooding is the dominant contributor to class IA scenarios at CPS. Some screening level events, such as the HFE for manual shutdown of the plant at the remote shutdown panel (RSP), if refined, may reduce the importance of these scenarios. Assuming there are no means of reducing probabilities of failing to evacuate the MCR or of controlling the plant from the RSP, physical modifications could be performed to protect the MCR from water ingress during flooding events (SAMA 6).
RCVSEQ-GTR-036	1.00E+00	3.69E-01	ACCIDENT SEQUENCE GTR-036	This is the accident sequence flag for GTR-036, which is a class IA sequence. The SAMAs identified for event RCVCL-1A are applicable.

Table 5-1a

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1XXPH-FLRSPRQH--	1.00E-01	3.06E-01	FAILURE TO SHUTDOWN PLANT USING REMOTE SHUTDOWN PANEL	The event is related to MCR flooding and the subsequent need to evacuate and perform plant shutdown from the remote shutdown panel. These are predominantly the Class IA scenarios discussed above for flag event RCVCL-1A.
1MCR-ABANDON	5.00E-02	3.06E-01	FLOOD (MAJOR) IN CB-1I CAUSES ABANDONMENT IN MCR	The event is related to MCR flooding and the subsequent need to evacuate and perform plant shutdown from the remote shutdown panel. These are predominantly the Class IA scenarios discussed above for flag event RCVCL-1A.
1DGRXDGREC30MH--	1.00E+00	2.91E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	The diesel recovery failure event is set to 1.0 (no credit taken for recovery of a failed diesel). No specific insights have been identified related to this event, though the same SAMAs that were identified for the %LOOP event would be applicable.
RCVCL-1BL	1.00E+00	2.10E-01	ACCIDENT CLASS IBL	This is a flag event that identifies the contributions from long term station blackout scenarios. Top contributors include primary FLEX pump failure (25%) and EDG failures (40% CCF and about 22% independent), and the failure to align power to the plant AC buses after offsite power recovery (11%). Because common cause failure is a major contributor to EDG unavailability and because establishing a basis for excluding an additional EDG from the same common cause group is difficult, an additional EDG is not suggested as a SAMA to address the CCF risk, but the independent failures are still large contributors (SAMA 20). A potential enhancement to address failure to align power to the emergency busses in a timely manner would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5). It is noted that RPV depressurization failure is include in LOOP-092; however, the FLEX generators are not credited in the model to provide SRV support for cases in which RCIC fails, but use of the generators is proceduralized and failures of the SRVs due to loss of power to the buses would be mitigated by existing capabilities. Fire protection injection could be used to prevent core damage in those long term scenarios, and if a hard piped connection was provided to allow rapid alignment of FPS to the RPV, it could potentially be used to mitigate short term injection failures and maintain RPV level while the FLEX generator was aligned (SAMA 10).

Table 5-1a

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%FLFPMMCR	8.68E-05	2.03E-01	FP FLOOD (MAJOR) IN CB-1I ABOVE MAIN CONTROL ROOM	MCR flooding is the dominant contributor to class IA scenarios at CPS. Some screening level events, such as the HFE for manual shutdown of the plant at the remote shutdown panel (RSP), if refined, may reduce the importance of these scenarios. Assuming there are no means of reducing probabilities of failing to evacuate the MCR or of controlling the plant from the RSP, physical modifications could be performed to protect the MCR from water ingress during flooding events (SAMA 6).
RCVSEQ-LOOP-092	1.00E+00	1.95E-01	ACCIDENT SEQUENCE LOOP-092	This event is a sequence marker flag. Sequence LOOP-092 is a long term SBO (IBL) scenario and the contributors are already addressed by the RCVCL-1BL event on this list.
RCVCL-2A	1.00E+00	1.24E-01	ACCIDENT CLASS IIA	This is the accident class IIA flag. There are a wide range of failures that contribute to this accident sequence, but the dominant contributor (95%) is the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which is addressed by SAMA 1. An additional large contributor is the failure to recover RHR given success of the "dump" of the upper pool to the main suppression pool (provides more time to reach PCPL). This is a data-based event and no specific insight has been identified related to RHR repair apart from that when RHR is not available, and alternate means of heat removal is required, which can also be accomplished with SAMA 1. An additional failure (28%) is related to the lack of power to a vent valve leading to the inability to operate the valve, and the assumption that it is initially in the correct "isolated" position. Again, SAMA 1 addresses this failure.
1CVPH-SMALLD-F--	1.00E+00	1.23E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	This event identifies that the small diameter vent paths are not a viable venting mechanism and not credit is taken for use of those paths. It is combined with failures of the credited vent path, 35% of which include failure of the in-containment vent path AOV failing to open due to environmental stress. Providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of addressing this risk, which would be part of the SAMA 1 design, but a smaller scope change would be to only replace the inboard containment isolation valve with one that is environmentally qualified (SAMA 8). Other contributors are failure of the operator to perform containment venting appropriately (29%) and lack of power to a vent path valve after successfully closing early in the scenario for containment isolation (28%). Both of these would potentially be mitigated by SAMA 1.

Table 5-1a

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APSYLOOPIESWF--	3.21E-01	1.13E-01	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	This event is the fractional contribution of LOOP events that are weather related. The contributors include failure of DC load shedding (25%), failure of the EDGs (21% independent failure), failure of the primary FLEX pump (20%), and the inability of the small containment vent paths to remove adequate heat from containment (18%). These contributors are addressed by SAMAs 3, 4, 2, and 1, respectively.
1RHRX-REC-UPDH--	2.19E-01	9.86E-02	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	This event represents the failure to recover the RHR system for heat removal given that the upper pool inventory was successfully transferred to the lower pool (provides more time to reach adverse containment conditions). 73% are Class IIA scenarios, which are addressed by the SAMAs discussed for the RCVCL-2A event. An additional 13% are Class IIV scenarios, which include successful containment vent followed by injection failure. A dominant contributor to the Class IIV scenarios is the failure to control the containment vent process to maintain NPSH for the pumps taking suction from the suppression pool. Currently, the CPS procedures do not provide specific guidance for controlling venting to preserve injection pump operation and operator training does not extend to long term scenarios to provide detailed practice on this action. A potential enhancement would be to include guidance in the EOPs related to controlling vent pressure to maintain NPSH and to include this action in the training program (SAMA 7). In addition, the probability of failing to properly align an adequate containment venting path is a significant contributor venting failure. Providing a pathway that is straightforward to use, is operable under adverse conditions without support systems, and having directions the clearly direct selection of the vent path would improve reliability (SAMA 4).
1SMSY-SUCC---F--	9.90E-01	9.86E-02	SUCCESS OF UPPER POOL DUMP	This event represents the successful transfer of the upper pool inventory to the lower pool (provides more time to reach adverse containment conditions). It is included in the same cutsets as event 1RHRX-REC-UPDH--- and the same SAMAs are applicable.

Table 5-1a

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVCL-1BE	1.00E+00	9.45E-02	ACCIDENT CLASS IBE	This is the accident class IBE flag. About 43% of the Class IBE contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). About 30% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar contributors for different time intervals. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).
RCVSEQ-LOOP-099	1.00E+00	8.99E-02	ACCIDENT SEQUENCE LOOP-099	This is the accident sequence LOOP-099 flag. This is accident class IBE and the SAMAs discussed to address the risk from event RCVCL-1BE are applicable to this event.
1DGDG-DGABC--XCC	2.78E-05	8.94E-02	DG A B AND C FAIL TO RUN - CC	This event represents common cause failure of the 3 emergency diesel generators. 71% are long term SBO events in which RCIC initially runs and the SAMAs for accident flag RCVCL-1BL are generally applicable. In addition, failure of the load shed action is about a 16% contributor. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed. This could support a checking process to improve the reliability of the action (SAMA 2).
RCVCL-4	1.00E+00	8.53E-02	ACCIDENT CLASS IV	This is an accident class flag for Class IV events. Over 94% of the contribution is due to mechanical scram failure, but this is a data-based event and no viable enhancements to improve the reliability of this function have been identified. Over 23% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9). In addition, there are multiple events representing the failure of the operators to control RPV level in an ATWS with FW available (for example, in the 15-36%). Installing an ATWS level control system that would reduce level to control power, inhibit ADS, and "terminate and prevent" injection from non-Feedwater systems would reduce the contribution from ATWS scenarios (SAMA 23).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RPSYRPS-MECHFCC	2.10E-06	8.24E-02	SCRAM SYSTEM HARDWARE FAILURE	This event represents the probability that a mechanical scram failure occurs. This is a data-based event and no viable enhancements to improve the reliability of this function have been identified. 98% of the contributors are Accident Class IV scenarios, and the SAMAs applicable to RCVCL-4 are also applicable to this event.
RCVCL-1D	1.00E+00	8.19E-02	ACCIDENT CLASS ID	This is an accident class flag for Class ID events, which are accident sequences involving a loss of coolant inventory makeup in which reactor pressure has been successfully reduced to 200 psi.; i.e., accident sequences initiated by common mode failures disabling multiple systems (ECCS) leading to loss of coolant inventory makeup. About 50% of the contribution is related to failure of the operators to manually initiate alternate injection systems; however, for cases that do not include operator failure to initiate injection, providing a hardpipe connection from the FPS to RHR would provide an alternate means of providing makeup to the RPV (SAMA 10). A 22% contributor is the event designating that the RCIC tank volume is inadequate for 24 hours. A potential means of reducing the risk from these contributors would be to modify procedures to direct alignment of makeup to the RCIC storage tank in non-ELAP scenarios to support long term injection (SAMA 19). A potential enhancement would be to develop flood area-specific procedures that would help operators identify flood sources and provide mitigation steps for the different flood sources (SAMA 25).
1APSYLOOPIESYF--	4.19E-01	7.93E-02	COND. PROBABILITY LOOP DUE TO SWYD EVENT	Similar to event 1APSYLOOPIESWF--, this is the fractional contribution of LOOP events that are related to events in the switchyard. The top contributors include failure of DC load shedding (26% independent and dependent) and failure of the EDGs (39% CCF and 21% independent) These contributors are addressed by SAMAs 3 and 4, respectively. Additional contributors include failure of the primary and alternate FLEX pumps. Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
%OPC-RAT	2.90E-03	7.73E-02	OPC OCCURS UPSTREAM OF RAT B INITIATOR	This event represents an open phase circuit upstream of the plant's Reserve Auxiliary Transformer, which supplies the 1B and 1C electrical divisions. There are currently alarms in the MCR that will alert the operators to this condition, and there are procedures to address the conditions and operators are trained on the condition. CPS has already made changes to alter the power supply configuration to the emergency buses based on industry experience - the power supplies are now split such that no single open phase circuit condition can fail all 3 emergency busses. The HEPs associated with the response to the condition are relatively low (about 2.5E-3 to 4.6E-3) and no specific procedure changes have been identified that would significantly reduce the HEPs. Over 70% of these scenarios are include failure to depressurize due to lack of DC power, but this condition would only exist after battery depletion and because several hours would be available before this would occur, the existing Blackstart capabilities that use portable DC supplies could support SRV operation, if needed. The PRA model does not currently include this capability and if it did, these contributors would be reduced. A potential enhancement would be to enhance procedures to direct alignment of the FLEX generator to supply the battery chargers if the AC supply is lost in non-ELAP scenarios (SAMA 24).
1APRXOSP6HRSWH--	4.97E-01	7.09E-02	FAILURE TO RECOVER OSP WITHIN 6 HOURS (WEATHER RELATED)	This event represents the failure to recover offsite power within 6 hours given that it was caused by a weather event. These are 99% long term SBO (IBL) scenarios and the contributors are generally addressed by the RCVCL-1BL event on this list. An exception is that there are no failure to restore power to the emergency busses after power recovery because this event represents failure to restore offsite power within 6 hours.
1FXPD-PRIFLEXX--	3.11E-01	6.58E-02	PRIMARY FLEX DD PUMP FAILS TO RUN	This event represents the failure of the primary FLEX pump to run and support suppression pool cooling in ELAP scenarios. Failure of the alternate pump to run is a 73% contributor while other failures that lead to loss of the cooling function provided by the pump make up the remainder of the contributors. Loss of these pumps represents the loss of the containment heat removal function that is used in the CPS FLEX strategy. A means of mitigating these scenarios would be to protect the RCIC tank such that it could be used in ELAP scenarios and enhance the containment venting capability such that it can support the decay heat removal function (SAMA 3).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-GTR-035	1.00E+00	6.03E-02	ACCIDENT SEQUENCE GTR-035	This is the accident sequence GTR-035 flag. This is accident class ID and the SAMAs for event RCVCL-1D are generally applicable, but the failure to align service water for alternate injection is a 75% contributor to this sequence, which limits the benefit of enhancing the FPS injection connection due to operator dependency issues. A potential enhancement would be to develop flood area-specific procedures that would help operators identify flood sources and provide mitigation steps for the different flood sources (SAMA 25).
1DCBC-DC06E--M--	2.01E-03	5.99E-02	CHARGER 06E OUT OF SERVICE FOR PREVENTIVE MAINTENANCE	This event represents the probability that the 06E charger is out of service for maintenance at the time of the initiating event. Over 78% of the contribution is related to open phase circuit initiators and the discussion of the risks and SAMAs identified for event %OPC-RAT are applicable to this event.
1RHRXDHRRECLTH--	4.04E-01	5.91E-02	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	This is a data-based event and no specific insight has been identified related to RHR repair apart from that when RHR is not available, and alternate means of heat removal is required, which can also be accomplished with SAMA 1 for about 78% of the contributors. SAMA 8 also provides a means of mitigating about 18% of the risk from these scenarios.
1CTSYLRGPCFLLR--	2.00E-01	5.61E-02	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability of a severe containment failure after overpressure in loss of containment heat removal scenarios. Over 95% include the event marking the inability of the smaller diameter vent paths being unable to adequately reduce containment pressure. Providing a full capacity containment vent path that is straightforward to use, can be operated without support systems, and is designed to work in adverse containment conditions would address these scenarios (SAMA 4). These scenarios include other events that lead to failure of the existing vent path, such as failing to operate the existing vent path (32%), failure of the inboard containment valve to operate due to environmental stress (48%), and failure of various components in the RHR system. For the contributors related to the failure of the inboard vent valve due to adverse environmental conditions, a smaller scope change of only replacing the valve with an environmentally qualified valve would be an effective change (SAMA 8).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
%TT	2.20E-01	5.37E-02	TURBINE TRIP WITH BYPASS INITIATOR	This event represents the turbine trip initiating event. For these initiators, most of the related sequences are ATWS events (89%), with failure to bypass the MSIV low level isolation interlock (37%) and level control failures (31%) being top contributors. SAMAs 10 and 11 are potential means of reducing the risk from these events.
1SXRX-RXSWINJH--	1.00E+00	5.37E-02	RX: OP FAILS TO INITIATE SX INJECTION THROUGH RHR DISCHARGE B	This event represents the action to align service water for RPV injection when it is part of a dependent action combination. COMB0001 is a 42% contributor and it includes the failure to isolate a major Aux Building flood in the early and late time frames in conjunction with the failure to align service water for injection. COMB0107 is a 19% contributor and it is the same as COMB0001 with the exception that it only includes the failure to isolate the flood in the early time frame (other events fail the equipment that the late isolation failure failed in the COMB0001 scenarios). Potential means of reducing the risk for these scenarios would be to provide flood area-specific procedures to aid the operators in the identification of flood sources and mitigation strategies (SAMA 25). Enhancing the fire protection system injection path by providing a hardpiped connection that could be quickly aligned for RPV makeup (SAMA 10) is a potential means of mitigating service water hardware failures and potentially execution failures committed during the service water alignment, though timing/staffing limitations could curtail credit for this change.
1APSYLOOPIEPCF--	2.18E-01	5.32E-02	COND. PROBABILITY LOOP DUE TO PLANT CENTERED EVENT	This event is the fractional contribution of LOOP events that are plant centered. The contributors include failure of DC load shedding (25%), failure of the EDGs (21% independent failure), failure of the primary FLEX pump (20%), and the inability of the small containment vent paths to remove adequate heat from containment (13%). These contributors are addressed by SAMAs 3, 4, 2, and 1, respectively.
1FXPD-ALTFLEXX--	3.11E-01	5.22E-02	ALT FLEX DD PUMP FAILS TO RUN	This event represents the failure of the alternate FLEX pump to run and support suppression pool cooling in ELAP scenarios after failure of the primary pump has already occurred. Loss of these pumps represents the loss of the containment heat removal function that is used in the CPS FLEX strategy. A means of mitigating these scenarios would be to protect the RCIC tank such that it could be used in ELAP scenarios and enhance the containment venting capability such that it can support the decay heat removal function (SAMA 3).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXOSP6HRSYH--	2.84E-01	5.18E-02	FAILURE TO RECOVER OSP WITHIN 6 HOURS (SWITCHYARD CENTERED)	This event represents the failure to recover offsite power within 6 hours given that it was caused by an event in the switchyard. These are 99% long term SBO (IBL) scenarios and the contributors are generally addressed by the RCVCL-1BL event on this list. An exception is that there are no failures to restore power to the emergency busses after power recovery because this event represents failure to restore offsite power within 6 hours.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
1CVPH-SMALLD-F--	1.00E+00	6.07E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	This event identifies that the small diameter vent paths are not a viable venting mechanism and no credit is taken for use of those paths. It is combined with failures of the credited vent path, which is dominated by failure of support systems required to operate the vent path components. Providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of addressing this risk (SAMA 4).
RCVCL-2A	1.00E+00	5.47E-01	ACCIDENT CLASS IIA	This is the Accident Class 2A flag (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure). The dominant contributor (>99%) is the inability of the small diameter vent paths to provide venting capabilities (see 1CVPH-SMALLD-F-- for details). Therefore, there are no additional SAMAs identified for this event.
F-ET-RELAY-SP	5.60E-01	4.83E-01	ERAT RELAY SPURIOUS PROBABILITY	This event represents the fire induced spurious relay operation that leads to loss of the ERAT. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1DGRXDGREC30MH--	1.00E+00	3.46E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	The DG recovery failure event is set to 1.0 (no credit taken for recovery of a failed diesel generator). Independent diesel generator failures are large contributors to risk at about 68% (for Div II). Providing an additional swing diesel generator that could be aligned to any power division could reduce the risk of these scenarios (SAMA 20). Additional contributors include failure of the containment vent paths (59%) and loss of power to the inboard containment vent valve after successful early containment isolation (17%). Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4).
1SMSY-SUCC---F--	9.90E-01	3.35E-01	SUCCESS OF UPPER POOL DUMP	This event represents the successful transfer of the upper pool inventory to the lower pool (provides more time to reach adverse containment conditions). Approximately 88% are Class 2A scenarios and 97% include containment vent failure, which are addressed by the SAMAs proposed for event 1CVPH-SMALLD-F--.
1APRXOSP20HPCH--	1.00E+00	2.98E-01	FAILURE TO RECOVER OSP WITHIN 20 HOURS (PLANT CENTERED)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). About 98% include failure of the containment vent paths, which could be addressed by installing a FLEX-like hardened containment vent that does not require support systems for operation (SAMA 4). 85% of the contributors are LOOP-053 sequences in which there is initial success of HPCS, failure of suppression pool cooling, and containment venting failure. Another 10% are LOOP-063 sequences, which are similar to LOOP-053, but the RPV is depressurized and low pressure injection is successful. Loss of suppression pool cooling is generally due to fire induced failures combines with other hardware failures, including failure of the EDGs (EDG B failure contributes over 23% with start and run failures and another 7.5% with maintenance unavailability). These contributors could be mitigated via the installation of an additional swing diesel generator that could be aligned to any electrical division (SAMA 20).
F-RT-RELAY-SP	5.60E-01	2.62E-01	RAT RELAY SPURIOUS PROBABILITY	This event represents the fire induced spurious relay operation that leads to loss of the RAT. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-GTR-024	1.00E+00	2.56E-01	ACCIDENT SEQUENCE GTR-024	This is the accident sequence GTR-024 flag. This is Accident Class 2A (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure) and the SAMAs discussed to address the risk from event RCVCL-2A are applicable to this event.
RCVSEQ-LOOP-053	1.00E+00	2.54E-01	ACCIDENT SEQUENCE LOOP-053	This is the accident sequence LOOP-053 flag. This is Accident Class 2A (loss of containment heat removal with the RPV initially intact; core damage induced post containment failure) and the SAMAs discussed to address the risk from event RCVCL-2A are applicable to this event.
RCVCL-1BE	1.00E+00	2.04E-01	ACCIDENT CLASS IBE	This is the Accident Class IBE flag (station blackout, early). Accounting for independent and dependent action contributions, approximately 43% of the Class IBE contributors include a failure to perform the DC load shed action. The reliability of this action could potentially be improved by including a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Additionally, EDG B failure contributes over 26% with start and run failures and another 8.3% with maintenance unavailability. These contributors could be mitigated via the installation of an additional swing diesel generator that could be aligned to any electrical division (SAMA 20). Events F-ET-RELAY-SP and F-RT-RELAY-SP are each about 50% contributors and the SAMAs applicable to those events are also applicable. The failure to align fire protection for RPV makeup (failure probability of 1.0) is about a 32% contributor, which could potentially be reduced by installing a hardpiped connection that would simplify and reduce the time required to perform the alignment (SAMA 10). In addition, failure to prevent and subsequently to isolate water hammer events are included in about 25% of the contributors. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CTSYLRGPCFLLR--	2.00E-01	1.99E-01	CONT. CATASTROPHIC FAILURE MODE	This event represents the probability of a severe containment failure after overpressure in loss of containment heat removal scenarios. Over 99% include the event marking the inability of the smaller diameter vent paths being unable to adequately reduce containment pressure (see 1CVPH-SMALLD-F-- for details). In addition, independent EDG failures lead to loss of decay heat removal capabilities (e.g., EDG B failure contributions from fail to run, start and maintenance unavailability are over 34%). Providing a swing diesel generator that can be aligned to any emergency AC power division would help reduce the risk of these scenarios (SAMA 20).
1DGDG-DG01KB-X-F	2.40E-02	1.97E-01	FAILURE OF DIESEL GENERATOR 01KB TO RUN (FIRE)	This event represents the failure to run of EDG 1B. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators.
1CTSYSTEAMBIND--	2.04E-01	1.86E-01	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	This event represents the likelihood of steam binding of the ECCS pumps taking suction off the suppression pool following containment failure. This is a data-based event and approximately 37% of its contribution is related to failure of the onsite diesel generators. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators. Over 99% include containment venting failure. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4). The failure to align fire protection for RPV makeup (failure probability of 1.0) is about a 26% contributor, which could potentially be reduced by installing a hardpiped connection that would simplify and reduce the time required to perform the alignment (SAMA 10).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CTSY-WWLOSS-R--	2.00E-01	1.82E-01	WW RUPTURE CAUSES LOSS OF WATER IN POOL	This event represents the likelihood of a catastrophic containment rupture due to a failure in the wetwell water space. This is a data-based event and approximately 37% of its contribution is related to failure of the onsite diesel generators. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators. Over 99% include containment venting failure. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4). The failure to align fire protection for RPV makeup (failure probability of 1.0) is about a 26% contributor, which could potentially be reduced by installing a hardpiped connection that would simplify and reduce the time required to perform the alignment (SAMA 10).
1FPOPALIGN-FPH-F	1.00E+00	1.81E-01	OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION	A number of alternate injection sources are available given loss of primary injection systems (i.e., feedwater, RCIC, HPCS, LPCS, LPCI). One alternate system is fire water injection via RHR B. This action requires operators to align fire water to RHR B following removal of the internals of one check valve in order to permit required flow. Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10).
1SXOP-RXSWINJH-F	1.00E+00	1.51E-01	OPERATOR FAILS TO INITIATE SX INJECTION THROUGH RHR DISCHARGE LINE B - FIRE PRA	This human failure event (HFE) is not credited in the Fire PRA due to insufficient timing. If a hardpiped connection between the fire protection system and RHR B was installed that could be rapidly aligned, about 80% of the contributors would be addressed. Over 54% include containment venting failure. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4). In addition, failure to prevent and subsequently to isolate water hammer events are included in about 45% of the contributors. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-LOOP-085	1.00E+00	1.20E-01	ACCIDENT SEQUENCE LOOP-085	This is the accident sequence LOOP-085 flag. This is Accident Class IBE (short term SBO with failure of high pressure injection, successful depressurization, and failure of low pressure injection systems) and the SAMAs discussed to address the risk from event RCVCL-1BE are applicable to this event, though water the hammer contribution is significantly higher at about 44%.
1CVMV-FAILOP-F--	1.00E+00	1.15E-01	MOTOR OPERATED VALVE FC007 CLOSES	This event represents a flag indicating that MOV 1FC007 has closed due to a loss of power. Providing a containment vent path that can be operated without support systems would reduce these contributors (SAMA 4). In addition, providing a swing diesel generator that can be aligned to any emergency AC power division would help ensure power is available for venting and potentially for suppression pool cooling, which would reduce the risk of scenarios that include this event (SAMA 20).
1APRXOSP30MPCH--	1.00E+00	1.03E-01	FAILURE TO RECOVER OSP WITHIN 30 MIN. (PLANT CENTERED)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). Events F-ET-RELAY-SP and F-RT-RELAY-SP are each over 70% contributors and the SAMAs applicable to those events are also applicable. Additionally, EDG B failure contributes over 44% with start and run failures and another 14% with maintenance unavailability. These contributors could be mitigated via the installation of an additional swing diesel generator that could be aligned to any electrical division (SAMA 20). The failure to align fire protection for RPV makeup (failure probability of 1.0) is about a 13% contributor, which could potentially be reduced by installing a hardpiped connection that would simplify and reduce the time required to perform the alignment (SAMA 10).
RCVCL-1A	1.00E+00	1.03E-01	ACCIDENT CLASS IA	This is the Accident Class 1A flag (loss of inventory makeup while at high pressure). Approximately 80% of the Class 1A contributors are associated with fire-induced spurious operation of ERAT relays and the SAMA associated with event F-ET-RELAY-SP is applicable to these contributors. Additionally, EDG C failure contributes over 24% with start and run failures and another 6% with maintenance unavailability. These contributors could be mitigated via the installation of an additional swing diesel generator that could be aligned to any electrical division (SAMA 20).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1SYSY-DRAINSPF--	1.00E+00	9.48E-02	LINE(S) DRAIN TO CREATE VOID	This event represents the probability that water will drain out of the ECCS and/or SX system lines after a LOOP occurs when the pumps had been running. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
F-WATERHAMMER	1.00E+00	9.48E-02	FLAG – WATER HAMMER	This event is a flag event to mark accident sequences that include water hammer events. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
%F_A-2K_1AP06E_H_Y2	1.10E-04	9.35E-02	Fire at 4.16kV MVSG 1AP06E (HEAF) – ZOI 2	This event represents the initiating event in which a high energy arcing fault (HEAF occurs at 4kv non-safety switchgear 1AP06E and fails targets within a zone of influence (ZOI) of 15 feet radius. This zone is located directly below the Division 1 Switchgear Room (A-2n) and is connected via an open stairwell. Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall and are included in the target set of this HEAF fire. For HEAF events, use of suppression has limited effectiveness, so protection of critical targets would be required to reduce the risk-significance of this initiating event. Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage (SAMA 27).
1RPRXYDCLOAD-H-F	1.00E+00	9.28E-02	RX: DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL (FIRE VERSION)	This event represents the failure of the operators to perform the DC load shedding task during ELAP scenarios to ensure the DC battery life is adequate to support implementation of FLEX strategies when it is in a combination of dependent operator actions. While the HEP is not large, there are estimated to be 20 minutes available for recovery actions after performance in the event if an error is made. The difficulty is finding the error with limited personnel. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed (SAMA 2). This could support a checking process improve the reliability of the action.
RCVSEQ-GTR-036	1.00E+00	9.22E-02	ACCIDENT SEQUENCE GTR-036	This is the accident sequence GTR-036 flag. This is Accident Class 1A (loss of inventory makeup while at high pressure) and the SAMAs discussed to address the risk from event RCVCL-1A are applicable to this event.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXOSP2HRPCH--	1.00E+00	8.60E-02	FAILURE TO RECOVER OSP WITHIN 2 HOURS (PLANT CENTERED)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). No specific insights have been identified related to this event, though the same SAMAs that were identified for basic events RCVCL-1BE would be applicable (100% of contributors including this event are 1BE).
RCVSEQ-LOOP-099	1.00E+00	8.40E-02	ACCIDENT SEQUENCE LOOP-099	This is the accident sequence LOOP-099 flag. This is Accident Class 1BE (station blackout, early) and the SAMAs discussed to address the risk from event RCVCL-1BE are applicable to this event; however, this sequence does not include water hammer events.
1RHOP-SPCVDE-H-F	1.00E+00	8.22E-02	OPERATOR FAILS TO VENT AND FILL AFTER LOOP (EARLY PUMP RESTART) (FIRE VERSION)	This event represents the failure of the operators to perform fill and vent of the ECCS or SX system before system start when the discharge lines have drained (creating a condition for water hammer). A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
%F_A-2N_1AP07E_E_G	2.24E-04	7.64E-02	Fire at 4.16kV MVSG 1AP07E (non-HEAF) - FIS Only	This event represents the initiating event in which an electrical fire originates at 4kV safety switchgear 1AP07E and is suppressed early such that the fire does not leave the switchgear. Given that this initiating event reflects the least severe fire that could originate from this ignition source, no new SAMAs have been identified for this initiating event. However, this initiating event would benefit from SAMA 20 (additional diesel generator) as nearly 50% of the risk associated with this initiating event involves failure of a diesel generator. Additionally, SAMA 14 (fire wrap of offsite power cables) and SAMA 4 (FLEX containment venting) would also reduce the risk-significance of this initiating event.

Table 5-1b

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1DGDG-DG01KB-M--	9.48E-03	7.33E-02	DG01KB OUT OF SERVICE MAINTENANCE	This event represents the probability that EDG B is out of service for maintenance at the time of the initiating event. 69% of the contributors include failure of containment venting. Providing a vent path that is qualified for adverse conditions and can be operated without support systems is a means of addressing this risk (SAMA 4). F-ET-RELAY-SP and F-RT-RELAY-SP are in 93% and 52% of the contributors, respectively, and the same SAMAs proposed to address those events are applicable. Fire initiators %F_A-2N_1AP07E_E_G and %F_A-2K_1AP06E_H_Y2 are 18% and 16% contributors, respectively, and the same SAMAs proposed to address those events are applicable. Finally, providing a swing diesel generator that could be aligned to any electrical division would provide a means of reducing the risk of these scenarios (SAMA 20).
1DGDG-DG01KA-X-F	2.40E-02	7.09E-02	FAILURE OF DIESEL GENERATOR DG01KA TO RUN (FIRE)	This event represents the failure to run of EDG 1KA. F-ET-RELAY-SP and F-RT-RELAY-SP are in 84% and 20% of the contributors, respectively, and the same SAMAs proposed to address those events are applicable. About 54% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4). About 9% of the contribution is from scenarios in which DC load shedding fails. This action could potentially be made more reliable if an additional step is included in the procedure to check that the current load on the batteries is within the expected/acceptable range after completion of the action (SAMA 2).
%F_A-2K_1AP06E_H_O	8.22E-05	6.97E-02	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF occurs at 4kv non-safety switchgear 1AP06E and the fire grows beyond the largest analyzed zone of influence (ZOI) and conservatively fails all targets within this zone. This zone is located directly below the Division 1 Switchgear Room (A-2n) and is connected via an open stairwell. Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall and are included in the target set of this HEAF fire. For HEAF events, use of suppression has limited effectiveness, so protection of critical targets would be required to reduce the risk-significance of this initiating event. Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage (SAMA 27).

Table 5-1b

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%F_CB-5A_1E22-S004_H_O	1.10E-04	6.40E-02	Fire at 4.16kV MVSG 1E22-S004 (HEAF) - Beyond ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF) occurs at 4kv safety-related switchgear 1C1 (1E22-S004) and the fire grows beyond the largest analyzed zone of influence (ZOI) and conservatively fails all targets within this zone. For HEAF events, use of suppression has limited effectiveness, so protection of critical targets would be required to reduce the risk-significance of this initiating event. The Division 3 Switchgear Room (CB-5a) is located south of the Division 1 Cable Spreading Room (CB-4) in the Control Building. Conduits C0734 and C0818, which support Division 1 equipment, are routed through CB-5a before they enter Fire Zone CB-5c. Rerouting these conduits through Fire Zone CB-1g, which is east of both CB-5a and CB-4 would reduce the risk-significance of this initiating event (SAMA 28).
1SYRX-ISOLWH-H-F	1.00E+00	6.15E-02	RX: OP FAILS TO DETECT & ISOLATE ANY FLOOD FROM WATER HAMMER EVENT (FIRE)	This event represents the probability that operators will fail to detect and isolate a flood caused by a water hammer event before it fails target equipment (1.0 HEP). A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
%F_A-2N_1AP07E_H_Y	8.78E-05	6.09E-02	Fire at 4.16kV MVSG 1AP07E (HEAF) - ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF) occurs at 4kV safety switchgear 1AP07E and fails targets within a zone of influence (ZOI) of 15 feet radius. Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available for non-Division 1 equipment (SAMA 4).
RCVCL-1BL	1.00E+00	5.66E-02	ACCIDENT CLASS IBL	This is the Accident Class IBL flag (station blackout, late). Failure to align fire protection for injection is included in about 30% of the contributors (HEP is 1.0). Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10). Additionally, random failure of the EDGs (including common cause failures) are about 18% (EDG 1KA) contributors. Providing an additional swing diesel generator that could be aligned to any power division could reduce the risk of these scenarios (SAMA 20).

Table 5-1b

CPS FPIE Level 1 Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RHSY-RHR-B--M--	6.54E-03	5.14E-02	RHR B TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that RHR B is out of service for maintenance at the time of the initiating event. Over 97% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4). Failure to align fire protection for injection is included in about 47% of the contributors (HEP is 1.0). Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10).
1APRXOSP6HRPCH--	1.00E+00	5.13E-02	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED)	Recovery of offsite power due to fire-induced failures is set to 1.0 (no credit taken for recovery of offsite power given fire-induced failures). No specific insights have been identified related to this event, though the same SAMAs that were identified for basic events RCVCL-1BE and RCVCL-1BL (station blackouts accident class) would be applicable.

Table 5-2a

CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RCVCL-H/L	1.00E+00	8.44E-01	ACCIDENT SEQUENCE H/L	This is a flag that identifies the "High-Late" release category. About 88% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. Additional contributors include failure of the primary and alternate FLEX pumps (25% and 20%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. About 60% of the contribution is associated with sequence LOOP-092 in which the RPV depressurization function has failed. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.
%LOOP	2.32E-02	7.57E-01	LOSS OF OFFSITE POWER INITIATOR	Addressed in the Level 1 Importance Review.
1CVPH-SMALLD-F--	1.00E+00	7.44E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Importance Review.
1DGRXDGREC30MH--	1.00E+00	6.06E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Importance Review.
RCVCL-1BL	1.00E+00	5.14E-01	ACCIDENT CLASS IBL	Addressed in the Level 1 Importance Review.
RCVSEQ-LOOP-092	1.00E+00	5.09E-01	ACCIDENT SEQUENCE LOOP-092	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RXF	1.00E+00	5.04E-01	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. About 88% of the scenarios with RX failure include the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 15% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Additional contributors include failure of the primary and alternate FLEX pumps (20% and 16%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios.
1OPPH-OP5-NOTFSU	8.20E-01	4.45E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBL)	This event represents the probability that the RPV is successfully depressurized before RPV breach in the Level 2 model for accident class IBL sequences. Over 88% of the contributors include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path, which occurs after core damage and leads to a High-Late release. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4). About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs suggested.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1HRSY-RHRCN--F--	1.00E+00	3.76E-01	CONTINGENCY METHODS INADEQUATE (NOT CREDITED)	This event represents the unavailability of other containment heat removal methods due to lack of procedures or capacity. Over 87% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 27% of the contributors, the FLEX primary pump fails to run in conjunction with other failures of the alternate FLEX pump that lead to loss of the normal containment heat removal strategy. Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1MCHU-PCSUNAVH--	1.00E+00	3.76E-01	PCS UNAVAILABLE AS HEAT SINK	This event is a flag event representing the unavailability of the main condenser as a heat sink. Over 87% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. For about 27% of the contributors, the FLEX strategy of providing suppression pool cooling with portable equipment fails. Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1APSYLOOPIESWF--	3.21E-01	3.48E-01	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1SIPH-SI4-NOTFSU	6.50E-01	3.26E-01	AC POWER SUCC. RECOVERED DURING SI TIME FRAME (CLASS IBL)	This event represents the probability that AC power is recovered in time to prevent drywell shell melt-through (AC power recovery is assumed to result in success on at least one injection system capable of providing adequate drywell injection). About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. Contributors include failure of the primary and alternate FLEX pumps (31% and 25%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.
1CTSY-WWLOSS-R--	2.00E-01	3.21E-01	WW RUPTURE CAUSES LOSS OF WATER IN POOL	This event represents the probability that a rupture occurs in the wetwell below the waterline that leads to loss of wetwell inventory. About 60% of the scenarios with RX failure include the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 16% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). The remaining vent failures are related to loss of power to a containment vent valve that is assumed to be isolated as part of normal processes early in the event (i.e., credit is not taken for the valve "failing open" to support venting) and failure of the operator to perform the venting action. The vent valve failure can be mitigated by the installation of an alternate vent path (SAMA 4), which could also reduce the venting failure probability due to its simplified design.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
B--OPDHR-EAL1F--	9.50E-01	2.83E-01	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the successful declaration of a general emergency in time to evacuate the population from the emergency protection zone in long term loss of decay heat removal cases before a significant release occurs (cases in which this action fails lead to "early" releases). Improving the reliability of this action would result in an increase to the risk of the associated scenarios and no such SAMAs are suggested here. Over 94% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. About 19% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Many of the remaining contributors include scenarios in which depressurization and/or low pressure injection fail, but most could be mitigated by the existing, unmodeled capability to depressurize and use low pressure injection form either a FLEX pump or the fire protection system. No additional SAMAs are proposed to address these scenarios, though the hardpiped connection for FPS injection (SAMA 10) would also reduce risk.
RCVCL-2A	1.00E+00	2.83E-01	ACCIDENT CLASS IIA	This is an accident sequence flag event that identifies loss of containment heat removal scenarios. 100% of the class IIA scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process (17%). About 19% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-IBL-048	1.00E+00	2.75E-01	ACCIDENT SEQUENCE IBL-048	This event is a Level 2 model accident sequence tag. The sequence includes a depressurized RPV before vessel breach, but failure to prevent vessel breach and while there is no drywell shell melt-through, a drywell isolation failure does occur. Suppression pool cooling and containment venting fail. All of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. Contributors include failure of the primary and alternate FLEX pumps (31% and 25%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. The magnitudes of the releases in these scenarios could be reduced by just providing FLEX-like hardpiped containment vent (SAMA 4). However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No additional SAMAs suggested.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-OP6-NOTFSU	9.30E-01	2.68E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	This event represents the successful depressurization after core damage. The contributors leading to sequences that include scenarios in which depressurization before core damage was not needed (high pressure injection functioned until containment failure followed by loss of injection). Over 94% of the scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 20% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). About 17% of the contribution includes catastrophic containment failure that fails the injection paths of the RPV injection systems. Preventing containment failure via the SAMAs proposed above are also effective means of reducing the risk of these scenarios. Over 18% of the contributors include failure of the operator to perform the venting action. Again, installation of a simplified, FLEX-like hardened vent system would reduce the probability of the failure of the venting action (SAMA 4).
1DGDG-DGABC--XCC	2.78E-05	2.47E-01	DG A B AND C FAIL TO RUN - CC	Addressed in the Level 1 Importance Review.
1APRXOSP6HRSWH--	4.97E-01	2.42E-01	FAILURE TO RECOVER OSP WITHIN 6 HOURS (WEATHER RELATED)	Addressed in the Level 1 Importance Review.

Table 5-2a

CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXL26HRSW-H--	8.03E-01	2.31E-01	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored within 6 hours to support depressurization and injection to prevent RPV breach for switchyard related LOOP events. About 99% of the contributors are from the LOOP-092 sequence in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. However, no credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the scenarios. No SAMAs suggested for this specific issue. In about 90% of the scenarios, the containment vent function fails. In The magnitudes of the releases in these scenarios could be reduced by providing FLEX-like hardpiped containment vent (SAMA 4). Additional contributors include failure of the primary and alternate FLEX pumps (31% and 24%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios.
1FXPD-PRIFLEXX--	3.11E-01	2.13E-01	PRIMARY FLEX DD PUMP FAILS TO RUN	Addressed in the Level 1 Importance Review.
1SMSY-SUCC---F--	9.90E-01	1.75E-01	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Importance Review.
1RHRX-REC-UPDH--	2.19E-01	1.75E-01	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	Addressed in the Level 1 Importance Review.
1FXPD-ALTFLEXX--	3.11E-01	1.72E-01	ALT FLEX DD PUMP FAILS TO RUN	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-LOOP-053	1.00E+00	1.70E-01	ACCIDENT SEQUENCE LOOP-053	This event is an accident sequence flag. The LOOP-053 sequence in one in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure (96%). RPV breach occurs in 97% of the contributors yet the RPV is depressurized in over 88% of them. These scenarios could potentially be reduced by installing a hardpiped connection that would simplify and reduce the time required to perform the alignment (SAMA 10) for injection to the RPV.
RCVCL-H/E	1.00E+00	1.56E-01	ACCIDENT SEQUENCE H/E	This is a flag that identifies the "High-Early" release category. About 58% of the contributors are CLASS IV (ATWS) events. The risk from these contributors can be reduced by providing an automatic ATWS RPV water level control system (SAMA 23) and/or by installing a switch in the MCR for bypassing the MSIV low RPV level isolation logic (SAMA 9). Hydrogen deflagration is a 30% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15).
1APSYLOOPIESYF--	4.19E-01	1.54E-01	COND. PROBABILITY LOOP DUE TO SWYD EVENT	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CVMV-FAILOP-F--	1.00E+00	1.51E-01	MOTOR OPERATED VALVE FC007 CLOSES	This event is used to represent the probability that a valve in one of the containment vent paths is closed at the time venting is required. It would normally be isolated early in the accident scenario and no credit is taken for the valve being left open in the even that motive power to the valve is lost (i.e., if motive power is lost, the valve is closed and cannot be opened for the containment venting function). About 97% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment venting process using the 480V portable generators to improve the existing containment venting capabilities (SAMA 12).
RCVL2-II-030	1.00E+00	1.50E-01	ACCIDENT SEQUENCE II-030	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is below the waterline (non-scrubbed release), a depressurized RPV, and a failure to prevent RPV breach. include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 33% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Enhancing the Fire protection system injection path to include a hardpiped connection that can be rapidly aligned could help prevent vessel breach and significantly reduce the magnitude of the release associated with these scenarios (SAMA 10).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RHRXDHRRECLTH--	4.04E-01	1.45E-01	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	Addressed in the Level 1 Importance Review.
1APSYLOOPIEPCF--	2.18E-01	1.34E-01	COND. PROBABILITY LOOP DUE TO PLANT CENTERED EVENT	Addressed in the Level 1 Importance Review.
1OPAD-ALTRNT-F--	1.00E+00	1.29E-01	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). The dominant conditions that include this event are loss of offsite power with a failure of one or more EDGs to power the battery chargers to support long term operation of the SRVs. The CPS FLEX strategy includes the alignment of the 480V battery chargers to support the SRVs, but it is conservatively not modeled for the relevant sequences. If the FLEX power alignment were to be included, these contributors would be significantly reduced and additional SAMAs would not be required (e.g., sequence LOOP-092 is a 54% contributor and RCIC operates successfully early, and LOOP-053 is a 15% contributor and HPCS operates successfully). Contributors include failure of the primary and alternate FLEX pumps (22% and 18%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. After core damage, providing a FLEX-like containment venting capability that would allow venting without support systems would reduce the risk of these contributors (SAMA 4). Similarly, enhancing the fire protection connection use for RPV makeup such that it could be rapidly aligned would reduce the magnitude of these contributors by potentially preventing RPV breach and/or containment failure by cooling debris (SAMA 10).
1OPPH-PRESBK-F--	8.00E-01	1.29E-01	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not cause by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-SORV---F--	8.10E-01	1.29E-01	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	3.00E-01	1.29E-01	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1CTPH-WW-NOT-F--	7.30E-01	1.27E-01	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	This event represents the probability that when containment overpressure failure occurs that the break will be above the torus water level line, which leads to release from the suppression pool that have passed through the water volume and have been "scrubbed". For loss of containment heat removal, failure of venting capability is, as in other scenarios, addressed by SAMA 1. Over 84% of the contribution includes initial early isolation of a containment vent valve with subsequent loss of power to the value, leading to the inability to open it, which could be mitigated with SAMA 1. Catastrophic containment failure, which fails the RPV injection paths, is only a 13% contributor, and in other cases, steam binding of pumps and failure to align fire protection for injection are contributors. Fire protection injection is conservatively assumed not to be available due to lengthy alignment times, but for these scenarios, this is conservative and the existing hardware and procedures would support injection and core damage could potentially be prevented. No SAMAs would necessarily be required to address these scenarios, however, providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10). Contributors also include failure of the primary and alternate FLEX pumps (29% and 24%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1DGDG-DGABC--ACC	1.36E-05	1.19E-01	DG A B AND C FAIL TO START - CC	This event represents common cause failure of the 3 emergency diesel generators. 94% are long term SBO events in which RCIC initially runs. There are multiple large contributors, including hydrogen deflagration at about 11% and failure of the containment vent path at 74%. Providing a battery backup to the hydrogen igniters could provide a means of prolonging operation until the FLEX generator is available to support them (SAMA 15), and providing a FLEX-like hardened vent would provide a simplified, reliable means of venting without support systems (SAMA 4).
1CXPH-H2-DEFGF--	1.00E+00	1.18E-01	HYDROGEN DEFLAGRATION OCCURS GLOBALLY	The event represents the assumption that hydrogen deflagration occurs after core damage. It is assumed that sufficient hydrogen is generated to lead to deflagration if an ignition source is present, and when the burn occurs, there is a potential for containment failure to occur. Long term station blackout represents about 58% of the risk associated with this event, and for these cases, the FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the remaining cases, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1CXPH-H2INVENF--	1.00E+00	1.18E-01	SUFFICIENT HYDROGEN GENERATED TO CAUSE OVERPRESSURE	The event represents the assumption that a hydrogen deflagration will result in containment overpressure if it occurs. When an overpressure event occurs, there is a potential for containment failure to occur. The event occurs in conjunction with event 1CXPH-H2-DEFGF-- and the same SAMAs are applicable.
1CXPH-STEAM--F--	9.00E-01	1.18E-01	CONTAINMENT NOT INERTED BY STEAM	The event represents the assumption that a hydrogen deflagration will result in containment overpressure if it occurs. When an overpressure event occurs, there is a potential for containment failure to occur. The event occurs in conjunction with event 1CXPH-H2-DEFGF-- and the same SAMAs are applicable.
1CZPH-DWFAIL-F--	9.00E-01	1.17E-01	CONDITIONAL PROBABILITY DRYWELL FAILS GIVEN DEFLAGRATION	The event represents the assumption that a hydrogen deflagration will result in containment overpressure if it occurs. When an overpressure event occurs, there is a potential for containment failure to occur. The event occurs in conjunction with event 1CXPH-H2-DEFGF-- and the same SAMAs are applicable.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1FXDGPRIFLEX-X--	2.19E-01	1.16E-01	PRIMARY FLEX DIESEL GENERATOR FAILS TO RUN	This event represents failure of the primary FLEX pump to provide flow for containment heat removal when the FLEX strategy has been implemented. Failure of the primary generator is generally paired with another failure the leads to the unavailability of the alternate generator such that all 480V AC power has been lost. Providing a swing diesel generator that can be aligned to any AC power division could help reduce the risk of these scenarios (SAMA 20).
1APRXOSP6HRSYH--	2.84E-01	1.12E-01	FAILURE TO RECOVER OSP WITHIN 6 HOURS (SWITCHYARD CENTERED)	Addressed in the Level 1 Importance Review.
1CXPH-CTCOND-F--	6.60E-01	1.10E-01	CONDITIONAL PROBABILITY CONT. FAILS GIVEN DW FAILS	This event represents the probability that the containment fails given that a failure of the drywell has occurred. 100% of the contributors are related to hydrogen deflagration cases. Hydrogen deflagration occurs primarily in scenarios where AC power is not available to 1) support igniter equipment that could initially prevent a hydrogen burn, and 2) are not available to serve as an ignition source. The FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the short term scenarios in which the FLEX generator may not be aligned before core damage, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-II-009	1.00E+00	1.09E-01	ACCIDENT SEQUENCE II-009	This event is an accident sequence flag. Over 99% of the contributions is from the LOOP-053 sequence in which HPCS operates early, SPC fails, venting fails, and post-venting injection failure leads to core damage. In the current model, the FLEX strategy for depressurizing the injecting with the fire protection system is not credited and if these existing capabilities were credited, the risk would be significantly reduced. Providing FLEX-like hardened containment vent (SAMA 4) would also reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
RCVL2-IBL-051	1.00E+00	1.06E-01	ACCIDENT SEQUENCE IBL-051	This event is a Level 2 model accident sequence tag. The sequence is a long term SBO scenario that includes success of RPV depressurization, RPV breach, no energetic failure of the DW, no energetic failure of containment, successful containment isolation, DW shell failure, failure of containment vent. 100% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. Providing a FLEX-like containment vent that is capable of operating without support systems would reduce the risk of containment failure (SAMA 4). Providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10) and provide a means of RPV makeup once the RPV is depressurized.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXL26HRSY-H--	6.47E-01	1.06E-01	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS. IN NODE OP, RX	This event represents the conditional failure to recover offsite power by 6 hours to support infection to prevent RPV breach after core damage. Over 98% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs are required to address these cases; however, about 88% of the contributors include failure to vent containment, which could be addressed by the implementation of a FLEX-like hardened containment vent (SAMA 4).
1HIPH-H2IGSBOF--	2.00E-01	1.05E-01	RANDOM HYDROGEN IGNITION GIVEN NO AC POWER	This event represents the probability that a random ignitions source cause hydrogen deflagration in scenarios where AC power is not available to 1) support igniter equipment that could initially prevent a hydrogen burn, and 2) are not available to serve as an ignition source. The FLEX strategies are not credited in the model for supplying power to the CPS hydrogen ignition system. If the FLEX power supply was credited in the model, the risk from hydrogen deflagration would be greatly reduced. For the short term scenarios in which the FLEX generator may not be aligned before core damage, providing battery backup to the igniters such that they would remain available until the generator could be aligned would reduce the risk from these scenarios (SAMA 15).
1APRXOSP6HRPCH--	3.74E-01	9.59E-02	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED)	This event represents the failure to recover offsite power within 6 hours given that it was caused by a plant centered event. These are 100% long term SBO (IBL) scenarios and the contributors are generally addressed by the RCVCL-1BL event on this list. An exception is that there are no failure to restore power to the emergency busses after power recovery because this event represents failure to restore offsite power within 6 hours.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXL26HRPC-H--	7.45E-01	9.37E-02	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored in time to prevent RPV breach after core damage. About 99% are LOOP-092 sequences in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. The Level 1 importance list addresses these cases. The level 2 contributors include sequence IBL-048 (63%) in which RPV depressurization is successful, RPV breach occurs, no energetic failure of the DW or containment occurs, containment isolation is successful but drywell isolation fails, late failure of containment does not occur, SPC fails, and containment venting fails. Providing a FLEX-like containment vent that is capable of operating without support systems would reduce the risk of containment failure (SAMA 4). Providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10) and provide a means of RPV makeup once the RPV is depressurized and RPV breach could potentially be averted. Sequence IBL-051 is similar to IBL-048, but late containment failure does occur, which could also be addressed by SAMA 7.
1HPPH-D3-XTIEF--	1.00E+00	9.32E-02	COND PROB THAT OPERATOR FAILS TO SWITCH BACK TO DIV 3 FOR HPCS INJ	This event represents the probability that the operators will fail to transfer power back to the HPCS bus to support the RPV makeup function after the HPCS diesel was cross-tied to Div I or II in order to provide power to other systems required to place the plant in a safe, stable state (e.g., supporting SPC). This is a proceduralized action for CPS, but the action is assumed to always fail, which artificially increases the CDF and release category frequency estimates. If the action to manage power between divisions was credited, the risk would be reduced and no SAMA would be required; however, for the contributing scenarios are 100% accident class II scenarios in which containment venting has failed. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APCBAP221A1-D--	5.37E-04	9.26E-02	CIRCUIT BREAKER 221 A1 FAILS TO OPEN (ERAT)	The event represents the probability that the breaker to the ERAT does not open to isolate the connection to the grid after loss of offsite power, which prevents the EDG from powering the emergency bus. While the Fire model does credit the operator to manually open this breaker if it fails to automatically open, the internal events model does not. The breaker status would be checked as part of the process to confirm the EDGs have powered the emergency bus after start and the process to open the breaker to the ERAT is part of the process covered by procedure. If the action was modeled for the internal events model, this risk related to this event would be greatly reduced and no SAMA would be required; however, for the contributing scenarios, 99% include containment venting failure that leads to core damage. Providing a FLEX-like containment vent capability that does not rely on support systems would address these contributors (SAMA 4).
RCVCL-4	1.00E+00	9.01E-02	ACCIDENT CLASS IV	Addressed in the Level 1 Importance Review.
1DGDG-DG01KB-X--	8.00E-03	8.81E-02	FAILURE OF DIESEL GENERATOR 01KB TO RUN	This event represents the failure to run of EDG 1KB. About 90% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 20). About 25% are related to event 1HPPH-D3-XTIEF--, which is already addressed in this importance list. Contributors also include failure of the primary and alternate FLEX pumps (30% and 25%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios.
1RPSYRPS-MECHFCC	2.10E-06	8.63E-02	SCRAM SYSTEM HARDWARE FAILURE	Addressed in the Level 1 Importance Review.
1FXDGALTFLEX-X--	2.19E-01	8.45E-02	ALTERNATE FLEX DIESEL GENERATOR FAILS TO RUN	This event represents failure of the alternate FLEX generator to provide power to the 480V busses when the FLEX strategy has been implemented. Failure of the alternate generator is generally paired with another failure the leads to the unavailability of the primary generator such that all 480V AC power has been lost. Providing a swing diesel generator that can be aligned to any AC power division could help reduce the risk of these scenarios (SAMA 20).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXL220HRSWH--	3.62E-01	8.21E-02	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 20.5 HRS. NODE SI	This event represents the conditional failure to recover offsite power by 20.5 hours to support injection to prevent drywell failure after core damage. Over 99% of the contributors are related to the LOOP-092 sequence in which RCIC is initially successful, but fails to provide long term injection and RPV depressurization is failed due to lack of support power. No credit is taken for the FLEX 480V DG or Blackstart capabilities to power the SRVs in these cases and if they were credited, the risk from depressurization failure would be greatly reduced for the H/L scenarios. No additional SAMAs are required to reduce the risk from these scenarios; however, 99% of the contributors do include a failure to vent containment. Providing a FLEX-like hardened containment vent capability that does not rely on support systems would address these contributors (SAMA 4).
1OPPH-OP8-NOTFSU	8.90E-01	8.10E-02	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IV)	This event represents the probability that the RPV is depressurized in time to prevent RPV breach. Fire protection injection is not credited to prevent RPV breach (1.0 failure probability) and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and H/E releases could potentially be reduced (SAMA 10).
RCVL2-IV-030	1.00E+00	8.05E-02	ACCIDENT SEQUENCE IV-030	This event is a containment event tree accident sequence flag. In this sequence, a wetwell airspace breach has occurred, the RPV is depressurized before breach, but in-vessel recovery of core debris fails and vessel breach does occur. Fire protection injection is not credited to prevent RPV breach (1.0 failure probability) and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and H/E releases could potentially be reduced (SAMA 10).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXOSP20HSWH--	2.49E-01	7.47E-02	FAILURE TO RECOVER OSP WITHIN 20 HOURS (WEATHER RELATED)	This event represents the probability that offsite power is not restored to the plant within 20 hours of the initial loss given that it was caused by a weather related event. About 99% of the contributors are accident class II scenarios in which containment failure leads to loss of the operating injection system. The vent failures are mostly related to loss of power to a containment vent valve (74% contributor) that is assumed to be isolated as part of normal processes early in the event (i.e., credit is not taken for the valve "failing open" to support venting) and failure of the operator to perform the venting action. The vent valve failure can be mitigated by the installation of an alternate vent path (SAMA 4), which could also reduce the venting failure probability due to its simplified design.
1DGDG-DG01KB-M--	9.48E-03	6.88E-02	DG01KB OUT OF SERVICE MAINTENANCE	This event represents the probability that the EDG "B" division is out of service for maintenance when an initiating event occurs. About 92% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4). About 34% are related to event 1HPPH-D3-XTIEF--, which is already addressed in this importance list. Contributors also include failure of the primary and alternate FLEX pumps (27% and 23%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. Providing a swing diesel generator that can be aligned to any AC power division could also help reduce the risk of these scenarios (SAMA 20).

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1DGDG-DG01KA-X--	8.00E-03	6.64E-02	FAILURE OF DIESEL GENERATOR DG01KA TO RUN	This event represents the failure to run of EDG 1KA. About 85% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 4). Contributors also include failure of the primary and alternate FLEX pumps (32% and 28%, respectively). Protecting the RCIC storage tank to allow use in ELAP scenarios and enhancing the FLEX strategy/procedures/containment venting capability to support use of the containment vent for heat removal/suppression pool temp control in cases when the pool cooling strategy fails (SAMA 3) could help reduce the risk of these scenarios. Hydrogen deflagration is a 16% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15). Providing a swing diesel generator that can be aligned to any AC power division could also help reduce the risk of these scenarios (SAMA 20).
1APRX-OSP-RX-H--	1.00E+00	6.62E-02	RX: OP FAILS TO REALIGN BUSES GIVEN SUCCESSFUL RECOVERY OF OSP	This event represents the failure to align power from the offsite source to the plant buses in time to prevent core damage. Installation of an emergency line from the offsite source to the plant buses powering mitigating equipment could reduce the probability related to alignment failures (SAMA 5).
1CVPH-TEMPF--F--	1.00E-02	5.52E-02	IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1)	This event represents the probability that the inboard containment vent air operated valve fails to open when required for venting. SAMA 1 suggests the installation of a hardpipe vent that other BWRs have implemented as part of the FLEX designs. An alternative may be to replace the inboard containment vent valve with one that is qualified to operate in severe accident conditions (SAMA 8).
%TT	2.20E-01	5.35E-02	TURBINE TRIP WITH BYPASS INITIATOR	Addressed in the Level 1 Importance Review.

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CPS FPIE Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1DGRXDGMANSTRH--	1.00E+00	5.16E-02	RX: OP FAILS TO MANUALLY START A DG IF AUTOSTART FAILS	This event represents the failure of the operator action to manually start an EDG after auto start failure when it is part of a dependent action failure combination. Because the hardware is not failed, providing an additional AC power source requiring manual alignment would have no impact due to operator dependency issues and such a SAMA is not suggested to address this event. About 78% of the contributors are related to the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--), which can be mitigate with the addition of a diverse, reliable vent path (SAMA 1.)Hydrogen deflagration is a 13% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15).

Table 5-2b

CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
RXF	1.00E+00	9.74E-01	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The event description indicates that RPV depressurization has failed, but the important sequences (over 85% of the contributors) indicate that RPV depressurization is successful. If the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach would be reduced, which would result and a lower magnitude release (SAMA 10). About 33% of the contribution includes failure of the containment venting function, and about half of them are related to failure of the inboard containment vent valve failing due to adverse conditions. These events can be addressed by SAMAs 4 and 8.
1CTPH-WW-NOT-F--	7.30E-01	8.11E-01	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV)	This event represents the probability that the location of the containment breach will be above the water line (leads to a scrubbed release). Generally, the pre-core damage contributors are diverse and overpressure is the result of both level/power control failures as well as failure of containment heat removal. Over 88% of the contributors are level 2 sequences in which the RPV is depressurized, RPV breach is not prevented, and the release occurs via a breach in the wetwell airspace(scrubbed). Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/L releases could potentially be reduced (SAMA 10).
RCVCL-M/E	1.00E+00	5.41E-01	ACCIDENT SEQUENCE M/E	This is a flag that identifies the "Medium-Early" release category. Over 97% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 80% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVCL-M/L	1.00E+00	4.59E-01	ACCIDENT SEQUENCE M/L	This is the accident flag event for the medium-low release category. As with the H/L release category, a large percentage (about 70%) of the scenarios include failure of the containment venting function, which can be addressed by SAMAs 4 and 8. Additionally, a major characteristic of the contributors is the successful depressurization of the RPV after core damage (over 98%), but the failure to prevent RPV breach (1.0 probability). The 1.0 probability for the prevention of vessel breach is due to the fact that injection after containment failure has failed to prevent core damage, which includes the potential for depressurization to fail; hence, if depressurization failure did not occur, then all injection has failed for other reasons. About 50% of the scenarios include catastrophic containment failures that fail the RPV injection paths (SAMAs 4 and 8 address). The remaining contributors include failure to control containment venting to maintain NPSH or containment failures that lead to steam binding of the pumps. Enhancing the venting procedure and training to manage NPSH during containment venting may reduce the risk from these scenarios (SAMA 7). Because the fire protection system is currently not credited in these long term scenarios when alignment would likely be possible, the risk from loss of injection due to steam binding is likely over estimated and no additional SAMAs are required, though SAMA 10 could further reduce risk.
1OPPH-OP6-NOTFSU	9.30E-01	4.51E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II)	The event represents the probability of successfully depressurizing the RPV before RPV breach in accident class II sequences. RPV breach is currently assumed to always occur; however, injection with fire protection could potentially prevent some failures in its current configuration. Further risk reductions could be realized by providing a hard piped connection for fire protection injection (SAMA 10). However, because catastrophic containment failure occurs in about 52% of the contributors, preventing containment failure is an important approach to reduce plant risk. Failure of containment venting is an 70% contributor (35% due to failure of the inboard valve due to adverse environmental conditions). Installing a hard pipe FLEX vent (SAMA 4) or replacing the valve with one that can function in adverse conditions (SAMA 8) are options to mitigate these scenarios.
RCVCL-4	1.00E+00	4.50E-01	ACCIDENT CLASS IV	Addressed in the Level 1 Importance Review.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
B--OPDHR-EAL1F--	9.50E-01	4.44E-01	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the successful declaration of a general emergency in time to evacuate the population from the emergency protection zone in long term loss of decay heat removal cases before a significant release occurs (cases in which this action fails lead to "early" releases). Improving the reliability of this action would result in an increase to the risk of the associated scenarios and no such SAMAs are suggested here. About 70% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). This includes the contribution of operator failure to use the existing vent path through the simplification of the containment venting process. About 35% of the cases could be addressed by the more limited scope enhancement of replacing the inboard vent valve with a valve capable of operating in adverse environmental conditions (SAMA 8). Many of the remaining contributors include scenarios in which depressurization and/or low pressure injection fail, but most could be mitigated by the existing, unmodeled capability to depressurize and use low pressure injection form either a FLEX pump or the fire protection system. No additional SAMAs are required to address these scenarios; however, enhancing the fire protection connection so that it can be rapidly aligned for RPV makeup could further reduce plant risk (SAMA 10).
1RPSYRPS-MECHFCC	2.10E-06	4.27E-01	SCRAM SYSTEM HARDWARE FAILURE	Addressed in the Level 1 Importance Review.
RCVL2-IV-008	1.00E+00	3.99E-01	ACCIDENT SEQUENCE IV-008	This event is a Level 2 model accident sequence flag. In this scenario, a containment failure has occurred above the water line in the suppression pool, the RPV is depressurized, but injection is not available to prevent RPV breach. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-OP8-NOTFSU	8.90E-01	3.99E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IV)	This event represents the probability that the RPV is depressurized in time to prevent RPV breach. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10).
1CVPH-SMALLD-F--	1.00E+00	3.30E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Importance Review.
1SMSY-SUCC---F--	9.90E-01	3.25E-01	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Importance Review.
1RHRX-REC-UPDH--	2.19E-01	3.25E-01	RHR FAILURE TO RECOVER WITH UPPER POOL DUMP SUCCESS	Addressed in the Level 1 Importance Review.
RCVL2-II-008	1.00E+00	3.19E-01	ACCIDENT SEQUENCE II-008	This event is a Level 2 model accident sequence tag. The sequence includes a depressurized RPV before vessel breach, but failure to prevent vessel breach with containment failure in the wetwell airspace (scrubbed release). The 1.0 probability for the prevention of vessel breach is due to the fact that injection after containment failure has failed to prevent core damage, which includes the potential for depressurization to fail; hence, if depressurization failure did not occur, then all injection has failed for other reasons. About 71% of the scenarios include catastrophic containment failures that fail the RPV injection paths (SAMAs 4 and 8 address). The around 24% of the contributors include failure of pumps taking suction from the suppression pool due to steam binding after rapid containment depressurization. Because the fire protection system is currently not credited in these long term scenarios when alignment would likely be possible, the risk from loss of injection due to steam binding is likely over estimated and no additional SAMAs are required, though SAMA 10 could further reduce risk.
RCVCL-2A	1.00E+00	3.16E-01	ACCIDENT CLASS IIA	Addressed in the Level 1 Importance Review.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
%LOOP	2.32E-02	2.92E-01	LOSS OF OFFSITE POWER INITIATOR	Addressed in the Level 1 Importance Review.
%TT	2.20E-01	2.62E-01	TURBINE TRIP WITH BYPASS INITIATOR	Addressed in the Level 1 Importance Review.
1CTSYLRGPCFLLR--	2.00E-01	2.37E-01	CONT. CATASTROPHIC FAILURE MODE	Addressed in the Level 1 Importance Review.
RCVSEQ-ATW1-030	1.00E+00	1.61E-01	ACCIDENT SEQUENCE ATW1-030	This is an accident sequence flag for Level 1 sequence ATW1-030. In this sequence, the condenser is not available for heat removal, but the feedwater/condensate pumps are available for injection. Level control/SLC injection failure leads to core damage. The operator action contribution from level control failure is over 84%. The installation of an ATWS level control system (SAMA 23) could potentially reduce the risk of these contributors.
1CVPH-TEMPF--F--	1.00E-02	1.61E-01	IN CONTAINMENT MOV/AOV FAILS CLOSED DUE TO ENVIRONM. STRESS (LEVEL 1)	This event represents the probability that the inboard containment vent air operated valve fails to open when required for venting. SAMA 4 suggests the installation of a hardpipe vent that other BWRs have implemented as part of the FLEX designs. An alternative may be to replace the inboard containment vent valve with one that is qualified to operate in severe accident conditions (SAMA 8).
1RPRX-LC-WMFWH--	1.00E+00	1.59E-01	RX: CREW FAILS TO CONTROL RPV WATER LEVEL EARLY TO REDUCE POWER WITH MDFW PMP	This event represents the failure of operators to control power in an ATWS by reducing RPV level with feedwater when it is part of a group of dependent operator action failures. Over 37% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9). In addition, there are multiple events representing the failure of the operators to control RPV level in an ATWS with FW available (for example, at over 85%). Installing an ATWS level control system that would reduce level to control power, inhibit ADS, and "terminate and prevent" injection from non-Feedwater systems would reduce the contribution from ATWS scenarios (SAMA 23).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-GTR-007	1.00E+00	1.45E-01	ACCIDENT SEQUENCE GTR-007	This is an accident sequence tag for the general transient tree in which HPCS operates in the long term without decay heat removal followed by containment failure. Over 65% of the risk is associated with a failure of the inboard containment vent valve to operate due to adverse environmental conditions. An additional 32% are related to operator failure to vent the containment. Installing a hard pipe FLEX vent that is straightforward to use (SAMA 4) or replacing the valve with one that can function in adverse conditions (SAMA 8) are options to mitigate these scenarios.
RCVSEQ-ATW1-008	1.00E+00	1.41E-01	ACCIDENT SEQUENCE ATW1-008	This is an accident sequence flag for Level 1 sequence ATW1-008. In this sequence, the condenser is not available for heat removal, but the feedwater/condensate pumps are initially available for injection, early SLC injection is successful, depressurization is successful, but failure to control level leads to core damage. The operator action contribution from level control failure when independent and dependent actions are accounted for is over 95%. The installation of an ATWS level control system (SAMA 23) could potentially reduce the risk of these contributors.
1RPRXLC-LATE-H--	1.00E+00	1.36E-01	RX: LATE RPV LEVEL CONTROL FAILS (CONDITIONAL) WITH FW	This event represents the failure of operators to control power in an ATWS by reducing RPV level with feedwater in the "late" time frame when it is part of a group of dependent operator action failures. Installing an ATWS level control system that would reduce level to control power, inhibit ADS, and "terminate and prevent" injection from non-Feedwater systems would reduce the contribution from ATWS scenarios (SAMA 23). In addition, over 37% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9).
1RHRXDHRRECLTH--	4.04E-01	1.28E-01	FAIL TO RECOVER DECAY HEAT REMOVAL LONG TERM	Addressed in the Level 1 Importance Review.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CVOPSECT25-6H--	1.73E-02	1.26E-01	OP FAILS TO CNMT VENT PROC (4411.06 SECT 2.5, 2.6)	This event represents the failure of the operator to vent the primary containment using pathways that do not involve the cutting of pipes. It is primarily an execution error that is used in conjunction with a separate event that represent the failure to diagnose the need to perform containment venting. The HEP is relatively large due to the extensive number of steps involved in the venting process. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4).
1SY--STEAMBOUND-	1.00E-02	1.24E-01	FAILURE TO CONTROL VENT CAUSES STEAM BINDING IN ECCS SUCTION	This event represents the probability of the low pressure ECCS pump failing after steam binding occurs when containment venting is not controlled and NPSH is lost. While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVCL-2V	1.00E+00	1.24E-01	ACCIDENT CLASS IIV	This is an accident sequence flag event that identifies loss of containment heat removal scenarios in which venting is performed successfully followed by core damage on loss of RPV makeup. 99.9% of the class IIV scenarios include the failure to control venting with a subsequent failure of the ECCS pumps that take suction from the suppression pool due to steam binding. Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7). While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).
1CTPH-WW-IIV-FSU	1.00E+00	1.24E-01	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS IIV)	Containment break above the water line is an event that characterize a scrubbed release from the wetwell because the fission products have passed through the wetwell water volume. These scenarios are over 100% related to cases in which containment venting is the condition that leads to the release from the wetwell. In these cases, the venting process is not controlled and loss of NPSH leads to failure of the ECCS pumps for RPV makeup and core damage occurs. Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7). While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-IIV-008	1.00E+00	1.19E-01	ACCIDENT SEQUENCE IIV-008	This event is an accident sequence flag that marks scenarios that include a loss of containment heat removal with subsequent successful containment venting. 99.9% of the cases include failure of ECCS pumps that take suction from the suppression pool due to steam binding of the pumps. Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7). While fire protection injection would be possible in many of these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).
DEPGROUP-COMB0042	7.31E-02	1.09E-01	HRA DEPENDENCY GROUP 0042	This event is a dependent action combination that includes early and late RPV level control failure in ATWS scenarios when using feedwater. The installation of an ATWS level control system (SAMA 23) could potentially reduce the risk of these contributors. About 45% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9).
1MSOP-LLINTLKH--	5.74E-01	1.05E-01	CREW FAILS TO BYPASS MSIV CLOSURE LOW LEVEL INTLK	This event represents the failure of the operators to bypass the low level MSIV isolation logic in an ATWS event before level falls below the isolation setpoint such that the main condenser isolates and is no longer available for heat removal. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9).
1MSPH-BIIT---F--	1.00E+00	1.05E-01	SUPPRESSION POOL TEMP EXCEEDS BIIT	This is a flag event that indicates the crew has failed to bypass the low level MSIV isolation logic such that the MSIVs go closed and the main condenser is lost as a heat sink. Installing a keylock switch to simplify the process would improve the reliability of the logic bypass action (SAMA 9).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RHSY-RHR-B--M--	6.54E-03	1.03E-01	RHR B TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that the RHR "B" division is out of service for maintenance when an initiating event occurs. The contributors to other RHR train failures are diverse, but venting failures (and subsequent containment failures that lead to loss of RPV makeup) are mostly due to the failure of the inboard containment vent valve to operate, support system unavailability, and operator failure to vent. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). In other contributors, the venting process is not controlled and loss of NPSH leads to failure of the ECCS pumps for RPV makeup and core damage occurs (about 35%). Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7).
1DGRXDGREC30MH--	1.00E+00	1.01E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Importance Review.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RHSY-RHR-A--M--	6.54E-03	9.44E-02	RHR A TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that the RHR "A" division is out of service for maintenance when an initiating event occurs. The contributors to other RHR train failures are diverse, but venting failures (and subsequent containment failures that lead to loss of RPV makeup) are mostly due to the failure of the inboard containment vent valve to operate, support system unavailability, and operator failure to vent. A potential means of reducing the risk associates with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). In other contributors, the venting process is not controlled and loss of NPSH leads to failure of the ECCS pumps for RPV makeup and core damage occurs (about 27%). Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7).
1CVOPVENTCTRLH--	5.00E-01	8.49E-02	VENT NOT CONTROLLED	This event represents the probability that the operators fail to control the containment venting process, which leads to loss of injection due to steam binding when NPSH is lost for the ECCS pumps taking suction from the suppression pool. Enhancing the procedures to provide explicit guidance and including the action in training programs on managing NPSH when venting in accident scenarios could help improvise the reliability of this action (SAMA 7). While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10). Installing a FLEX-like hard-piped containment vent that would simplify the venting process could also improve the reliability of the vent control action (SAMA 4).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-LOOP-006	1.00E+00	8.14E-02	ACCIDENT SEQUENCE LOOP-006	This event is an accident sequence flag. The LOOP-066 sequence in one in which RCIC and HPCS operate early, SPC fails, venting fails, and post-venting injection failure leads to core damage. Almost all contributors include either the failure of the operator to vent the containment or the failure of the inboard containment vent valve to operate in adverse conditions. A potential means of reducing the risk associated with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8).
1APSYLOOPIESWF--	3.21E-01	7.87E-02	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	Addressed in the Level 1 Importance Review.
1CTSYSTEAMBIND--	2.04E-01	7.81E-02	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	This event represents the probability of the low pressure ECCS pump failing after steam binding occurs when containment fails and NPSH is lost. Almost all contributors include either the failure of the operator to vent the containment or the failure of the inboard containment vent valve to operate in adverse conditions. A potential means of reducing the risk associated with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8). While fire protection injection would likely be possible in these long term scenarios with existing capabilities, it is not credited. A potential improvement to further reduce the risk of the scenarios would be to provide a hard piped injection path that would allow a simplified process to align Fire Protection injection to the RPV (SAMA 10).
1FWRXFLWCTRLAH--	1.00E+00	7.43E-02	RX: OP FAILS TO PROP CONT FW FLOW FOR RX LVL CONT (ATWS)	This event represents the failure of the operators to control reactor water level in an ATWS scenario using the feedwater system when it is included in a dependent action combination. The installation of an ATWS level control system (SAMA 23) could potentially reduce the risk of these contributors.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RPOP-LC-WSLCH--	4.68E-02	6.95E-02	OPERATOR FAILS TO CONTROL LEVEL (EARLY SLC SUCCESSFUL)	This event represents the failure of the operators to terminate/prevent injection from non-FW systems to prevent vessel overfill when the feedwater system is available for injection. The installation of an ATWS level control system that automatically performs the "terminate and prevent" action (SAMA 23) could potentially reduce the risk of these contributors.
1OPAD-ALTRNT-F--	1.00E+00	6.83E-02	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). Over 62% include failure of the SRVs to operate due to adverse environmental conditions in the Aux Building. Protecting the equipment or replacing it with equipment qualified to operate in adverse conditions could address these failures (SAMA 17). About 12% include SBO scenarios with load shed failures that lead to early loss of RCIC and depressurization capability. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 74% are ATWS scenarios with level control failures contributing about 30%. The installation of an ATWS level control system that automatically performs the "terminate and prevent" action (SAMA 23) could potentially reduce the risk of these contributors. About 19% of the contribution is related to the failure of the operator action to bypass the MSIV low level isolation logic. Installing a keylock switch to simplify the process would improve the reliability of this action (SAMA 9).
1OPPH-PRESBK-F--	8.00E-01	6.83E-02	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not caused by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	8.10E-01	6.83E-02	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-TEMPBK-F--	3.00E-01	6.83E-02	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
F-WATERHAMMER	1.00E+00	6.79E-02	FLAG - WATER HAMMER	This event is a flag event to mark accident sequences that include water hammer events. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
1SYSY-DRAINSPF--	1.00E+00	6.79E-02	LINE(S) DRAIN TO CREATE VOID	This event represents the probability that water will drain out of the ECCS and/or SX system lines after a LOOP occurs when the pumps had been running. A potential means of reducing the risk of these scenarios would be to include explicit guidance in the Loss of AC Power procedure to help prevent water hammer after LOOP events (SAMA 26).
RCVCL-1BE	1.00E+00	6.71E-02	ACCIDENT CLASS IBE	Addressed in the Level 1 Importance Review.
RCVSEQ-LOOP-099	1.00E+00	6.71E-02	ACCIDENT SEQUENCE LOOP-099	Addressed in the Level 1 Importance Review.
%MS	1.50E+00	6.53E-02	MANUAL SHUTDOWN INITIATOR	This event represents the probability that a manual shutdown is initiated during power operations. Over 84% are cases in which RPV injection is initially available, containment heat removal fails, venting fails, and injection is lost after containment failure. A potential means of reducing the risk associated with the scenarios including thins event is to enhance the containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4) (70%), or by installing a containment vent valve that is qualified to operate in extreme environmental conditions (SAMA 8) (41%).

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
F-L2-CIV	1.00E+00	6.52E-02	FIRE FLAG FOR LEVEL 2 CONT ISOL VALVE FAILURE	This event is a flag that marks cases in which one or more containment isolation valves has failed to isolate. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are also LOOP-099 sequences. In the LOOP-099 sequences, RCIC, HPCS, and depressurization fail leading to subsequent core damage. Over 72% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 83% of the contribution includes successful depressurization after core damage, yet RX is assumed to be failed. If the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach could potentially be reduced (SAMA 10).
1RPRX-LC-WSLCH--	1.00E+00	6.43E-02	RX: OP FAILS TO CONTROL LEVEL (EARLY SLC SUCCESSFUL)	This event represents the failure of the operators to terminate/prevent injection from non-FW systems to prevent vessel overfill when the feedwater system is available for injection when it is part of a group of dependent operator actions. The installation of an ATWS level control system that automatically performs the "terminate and prevent" action (SAMA 23) could potentially reduce the risk of these contributors.
1OPPH-OP7-NOTFSU	8.30E-01	5.58E-02	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBE)	This event represents the probability that RPV depressurization occurs before vessel breach. Over 95% of the contribution containing this event is associated with the LOOP-099 sequence and they are all "early" SBO scenarios. Over 72% of the contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). About 10% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar contributors for different time intervals. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).

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CPS FPIE Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-ATW1-002	1.00E+00	5.46E-02	ACCIDENT SEQUENCE ATW1-002	This is the accident sequence ATW1-002 flag. In this sequence, Feedwater and the main condenser are available, but SLC/level control fails, leading to core damage. About 88% of the contribution is associated with failing to control level with feedwater. The installation of an ATWS level control system that automatically performs the "terminate and prevent" action (SAMA 23) could potentially reduce the risk of these contributors.
RCVL2-IBE1-063	1.00E+00	5.40E-02	ACCIDENT SEQUENCE IBE1-063	This event is a containment event tree accident sequence flag that marks scenarios that include successful RPV depressurization, failure to prevent RPV breach, no energetic failure of the containment or drywell, containment and drywell isolation failure, failure of injection to prevent containment failure, and failure of containment sprays. Over 72% of the contributors include a failure to perform the DC load shed action. Including a procedure step to confirm the battery current is within the required range would potentially help recover from errors in the process and improve the reliability of the action (SAMA 2). About 10% of the contributors include a failure to align offsite power to the plant buses after recovery of power to the switchyard within 30 minutes. There are several similar contributors for different time intervals. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-V-02	1.00E+00	1.00E+00	ACCIDENT SEQUENCE V-02	This is the accident sequence marker for containment event tree sequence V-02, which is the only class V sequence and provides no specific insights. No SAMAs identified.
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
BSYPH-LERF---F--	1.00E+00	1.00E+00	COND. PROB. OF A LERF (CLASS V)	This event represents the conditional probability that the class V event are LERF, which is included in all cutsets in the HE/BOC release category and provides no specific insights. No SAMAs identified.
RCVCL-5	1.00E+00	1.00E+00	ACCIDENT CLASS V	This event is an accident class flag for class v events, which is included in all cutsets in the HE/BOC release category and provides no specific insights. No SAMAs identified.
RCVCL-H/E	1.00E+00	1.00E+00	ACCIDENT SEQUENCE H/E	This event is an accident sequence flag for class H/E events, which is included in all cutsets in the HE/BOC release category and provides no specific insights. No SAMAs identified.
1SXOP-INIT-L-H--	3.55E-01	9.00E-01	OPERATOR FAILS TO ALIGN SX FOR LG OR MED STEAM LOCA (WITH EARLY INJECTION)	This event represents the probability that the operators will fail to align the Service Water (SW) system for long term RPV injection in time to prevent core damage. The HEP is driven by the short diagnosis and recovery time that has been assumed for the action, which includes a 20 minute system window (time within which the action must be complete) and an execution time of 16 minutes. The calculation notes that the system window is conservative for most scenarios and the alignment time currently accounts for local breaker manipulation associated with operation of the cross-tie valve between RHR and the SW system. The local breaker manipulation is not assumed to be performed in parallel with other tasks, which may increase the execution time estimate. The breaker is normally not installed to reduce the risk of inadvertent operation of the valve and no change is suggested for the breaker. A potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without impacting the conditions associated with the SW to RHR cross-tie valve (SAMA 18).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVSEQ-BOC-002	1.00E+00	8.32E-01	ACCIDENT SEQUENCE BOC-002	This is an accident sequence tag for the break outside containment event tree which includes successful scram, success of HPCS, and a failure of long term, low pressure injection. Over 98% of the contributors include failure of the operator action to align service water for long term, low pressure injection. This event (1SXOP-INIT-L-H--) is addressed on this list and the same SAMA is applicable.
%BOC-MS	7.04E-10	5.30E-01	BOC INITIATOR IN MAIN STEAM SYSTEM	This is an initiating event representing the probability of a break outside containment in the main steam system. Over 98% of the contributors include failure of the operator action to align service water for long term, low pressure injection. This event (1SXOP-INIT-L-H--) is addressed on this list and the same SAMA is applicable.
%BOC-RW	2.01E-10	1.51E-01	BOC INITIATOR IN RWCU SUCTION LINE	This is an initiating event representing the probability of a break outside containment in the RWCU suction line. Over 98% of the contributors include failure of the operator action to align service water for long term, low pressure injection. This event (1SXOP-INIT-L-H--) is addressed on this list and the same SAMA is applicable.
%BOC-RC	2.01E-10	1.51E-01	BOC INITIATOR IN RCIC STEAM LINE	This is an initiating event representing the probability of a break outside containment in the RCIC steam line. Over 98% of the contributors include failure of the operator action to align service water for long term, low pressure injection. This event (1SXOP-INIT-L-H--) is addressed on this list and the same SAMA is applicable.
RCVSEQ-ISLOCA-002	1.00E+00	8.80E-02	ACCIDENT SEQUENCE ISLOCA-002	This event is an accident sequence flag for ISLOCA-002 events, which includes successful scram, success of HPCS, and a failure of long term low pressure injection. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%ISLOCA-SDC	3.84E-11	8.02E-02	INTERFACING SYSTEM LOCA INITIATOR IN SDC SUCTION LINE	This is an initiating event representing the probability of an interfacing system LOCA in the shutdown cooling suction line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long term, low pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18). The CPS ISLOCA frequencies do not credit early isolation of valves in the break pathways due to inability of the valves to close against the high flow and pressure differential. Long term isolation is not credited as initial isolation actions are assumed to fail the valves due to thermal overload, though recovery of this conditions is generally not complicated. A potential SAMA that could reduce uncertainty in the mitigation of ISLOCA scenarios would be replace valves in critical flow paths with one that is designed to close in ISLOCA condition (SAMA 11).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%BOC-HP	1.08E-10	8.00E-02	BOC INITIATOR IN HPCS INJECTION LINE	This is an initiating event representing the probability of a break in the HPCI injection line outside of containment. This event is in a single cutset in which HPCS is failed by the initiator and long term, low pressure injection is failed due to operator action. The frequency of the initiator already accounts for failure of the testable check valve to prevent flow out of the RPV and there are no explicit valve qualification issues related to the failure to isolate for this event. The HEP for SW injection alignment is driven by long execution time relative to the time available for response, which is primary due to the need to perform a local breaker manipulation. The breaker is normally not installed to reduce the risk of inadvertent operation of the valve and no change is suggested for the breaker. The time to provide low pressure RPV makeup for this event using the service water system is limited to 20 minutes, which does not account for the time other low pressure injection systems, such as core spray and LPCI, could initially operate (automatically) with suction from the suppression pool to delay core damage while the SW injection alignment was completed. If the time to core damage accounted for the time the existing LPI systems could provide injection before suppression pool inventory depletion, the risk of this scenario would be reduced and no SAMAs would be required. No SAMAs are suggested for this specific event.
RCVSEQ-BOC-004	1.00E+00	8.00E-02	ACCIDENT SEQUENCE BOC-004	This event is an accident sequence flag for ISLOCA-004 events, which includes successful scram, failure of HPCS, and a failure of long term low pressure injection. This is a single cutset contributor that is addressed by event %BOC-HP.
1RHSY-RHR-B--M--	6.54E-03	1.51E-02	RHR B TAGGED OUT FOR MAINTENANCE OR TESTING	This event represents the probability that RHR train "B" is out of service for maintenance. In the contributing sequences, the ISLOCA or BOC initiator does not fail the RHR B injection path, but the maintenance event prevents it from being used for RPV makeup. HPCS is initially successful. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1RHXV-2F039B-P--	2.30E-03	3.39E-03	INJECTION LINE MANUAL VALVE F039B PLUGGED	Similar to the RHR maintenance event, the unavailability of the RHR "B" injection valve precludes long term, low pressure injection sources from injecting to the RPV. HPCS is initially successful in the scenarios in which this event is a contributor. To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-LPB	1.25E-12	2.61E-03	INTERFACING SYSTEM LOCA INITIATOR IN RHR LPCI INJ B	This is an initiating event representing the probability of an interfacing system LOCA in the LPCI "B" injection line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long term, low pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).
%ISLOCA-SDCB	1.25E-12	2.61E-03	INTERFACING SYSTEM LOCA INITIATOR IN SDC RETURN TRAIN B	This is an initiating event representing the probability of an interfacing system LOCA in the shutdown cooing "B" return line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long term, low pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).

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CPS FPIE Level 2 High-Early Break Outside Containment (BOC) Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%ISLOCA-LPC	1.25E-12	2.61E-03	INTERFACING SYSTEM LOCA INITIATOR IN RHR LPCI INJ C	This is an initiating event representing the probability of an interfacing system LOCA in the LPCI "C" injection line. This event is in a single cutset in which HPCS is successful, inventory is depleted, and long term, low pressure injection is failed due to the location of the initiator break (prevents SW and fire protection injection through RHR). To take advantage of HPCS success, a potential means of reducing the risk from these scenarios would be to install an emergency refill line to the RCIC Storage Tank from the SW system. This would provide an indefinite supply for the pumps taking suction from the RCIC Storage Tank without relying on the current RHR injection path (SAMA 18).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1--SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	This is the plant availability factor, which is included in every cutset and provides no insights related to potential means of reducing plant risk. No SAMAs identified.
1CVPH-SMALLD-F--	1.00E+00	9.46E-01	SMALL DIA VENTS ASSESSED AS UNSUCCESSFUL (4411.06 PROC SECT 2.3 & 2.4)	Addressed in the Level 1 Fire Importance Review.
RCVCL-H/L	1.00E+00	9.38E-01	ACCIDENT SEQUENCE H/L	This is a flag that identifies the "High-Late" release category. About 97% of these scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 82% of the contribution is associated with sequences LOOP-053 and GTR-024 in which RCIC fails, but HPCS provides injection until containment failure leads to loss of injection, but catastrophic containment failure occurs in only 23% of the contributors. In the cases without catastrophic containment failure, the existing fire protection injection approach would likely be capable of providing makeup, but it is not credited. Providing a hard-piped connection that would simplify fire protection injection and reduce the time required to align the system would help further reduce these risks (SAMA 10). Independent failures of the EDGs are also large contributors (e.g.,. EDG B is a 44% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RXF	1.00E+00	8.92E-01	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. Over 85% of the contributors include successful depressurization of the RPV before breach. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.
B--OPDHR-EAL1F--	9.50E-01	8.70E-01	GEN. EMERG. DECLARED EARLY DURING LOSS OF DHR PER EAL INTERPRETATION	This event represents the probability that operators successfully declare a general emergency in time to evacuate the population from the emergency protection zone before a significant release in loss of containment heat removal scenarios (Accident Class 2). Over 98% of the contribution includes the event that indicates that containment venting has failed and that the remaining vent paths were inadequate to provide adequate pressure relief/heat removal. The risk from these cases could be reduced if plant enhanced its containment vent capability such that it can be used without support systems and is straightforward to use (SAMA 4). In addition, over 88% of the contribution is from the LOOP-053 and GTR-024 sequences in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. Catastrophic containment failure occurs in about 25% of the case, but in the remaining scenarios, providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach.
RCVCL-2A	1.00E+00	8.31E-01	ACCIDENT CLASS IIA	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-OP6-NOTFSU-F	8.80E-01	7.55E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS II) (FIRE)	This event represents the successful depressurization after core damage. The contributors leading to sequences that include scenarios in which depressurization before core damage was not needed (high pressure injection functioned until containment failure followed by loss of injection). Over 98% of the scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). About 24% of the contribution includes catastrophic containment failure that fails the injection paths of the RPV injection systems. Preventing containment failure via SAMA 1 is also an effective means of reducing the risk of these scenarios. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 57% and 27% contributors, respectively. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14).
F-ET-RELAY-SP	5.60E-01	5.86E-01	ERAT RELAY SPURIOUS PROBABILITY	Addressed in the Level 1 Fire Importance Review.
1SMSY-SUCC---F--	9.90E-01	5.66E-01	SUCCESS OF UPPER POOL DUMP	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-GTR-024	1.00E+00	4.72E-01	ACCIDENT SEQUENCE GTR-024	Addressed in the Level 1 Fire Importance Review.
1CTSY-WWLOSS-R--	2.00E-01	4.64E-01	WW RUPTURE CAUSES LOSS OF WATER IN POOL	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CTPH-WW-NOT-F-F	6.80E-01	4.55E-01	CONTAINMENT BREACH ABOVE THE WTR LINE (CLASS I, IIA, IIT, III, IV) (FIRE)	This event represents the probability that when containment overpressure failure occurs that the break will be above the torus water level line, which leads to release from the suppression pool that have passed through the water volume and have been "scrubbed". For loss of containment heat removal, failure of venting capability is, as in other scenarios, addressed by SAMA 1. Over 28% of the contribution includes initial early isolation of a containment vent valve with subsequent loss of power to the value, leading to the inability to open it, which could be mitigated with SAMA 1. Catastrophic containment failure, which fails the RPV injection paths, is a 48% contributor, and preventing containment overpressure failure with SAMA 1 would address these scenarios. In other cases (also about 48%), steam binding of pumps and failure to align fire protection for injection are contributors. Fire protection injection is conservatively assumed not to be available due to lengthy alignment times, but for these scenarios, this is conservative and the existing hardware and procedures would support injection and core damage could potentially be prevented. No SAMAs would necessarily be required to address these scenarios, however, providing a hard-piped connection between fire protection and the RHR systems would improve the reliability of the fire protection injection action (SAMA 10). Independent failures of the EDGs are also large contributors (e.g. FTR, FTS, and maintenance unavailability for EDG B are in 52% of the contributors) and can be address by installation of a diesel generator that can be aligned to any AC division (SAMA 20).
1DGRXDGREC30MH--	1.00E+00	4.17E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Fire Importance Review.

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Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-II-030	1.00E+00	3.65E-01	ACCIDENT SEQUENCE II-030	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is below the waterline (non-scrubbed release), a depressurized RPV, and a failure to prevent RPV breach. Over 99% include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). Enhancing the Fire protection system injection path to include a hardpiped connection that can be rapidly aligned could help prevent vessel breach and significantly reduce the magnitude of the release associated with these scenarios (SAMA 10). Fire induced failures account for some of the inability to provide alternate injection, including from the FPS. F-RT-RELAY-SP (24%) leads to failure of the MOVs in the alignment path and protecting the cables related to offsite power feeds will reduce the risk of these sequences (SAMA 14) (F-ET-RELAY-SP is an additional 47% contributor).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-II-009	1.00E+00	3.51E-01	ACCIDENT SEQUENCE II-009	This event is a level 2 CET accident sequence flag. In the Level 2 sequence, there is no wetwell airspace breach, the RPV is depressurized, RPV breach occurs, there is no energetic containment or DW failure, and the suppression pool is bypassed by the containment failure (the release is not scrubbed). Over 95% of the Level 1 contributors are from the LOOP-053 and GTR-024 sequences in which HPCS operates early, SPC fails, venting fails, and post-containment failure injection loss leads to core damage. Providing FLEX-like hardened containment vent (SAMA 4) would reduce the risk associated with containment vent failure. The FLEX strategy does at CPS does not require containment venting and SBO scenarios and other scenarios with loss of power to the 480V emergency buses that power the valves used in the venting process are not completely supported by the FLEX generator alignment. There are procedures available to vent containment without power, but the procedure relies on the assumption that a set of containment isolation valves remain open (loss of power leaves them in the normally open position). Procedure modifications could be performed to provide clear direction to support the containment venting process using the 480V portable generators to improve the containment venting capabilities (SAMA 12).
1APRXOSP20HPCH--	1.00E+00	3.49E-01	FAILURE TO RECOVER OSP WITHIN 20 HOURS (PLANT CENTERED)	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-LOOP-053	1.00E+00	3.32E-01	ACCIDENT SEQUENCE LOOP-053	Addressed in the Level 1 Fire Importance Review.
1DGDG-DG01KB-X-F	2.40E-02	2.70E-01	FAILURE OF DIESEL GENERATOR 01KB TO RUN (FIRE)	Addressed in the Level 1 Fire Importance Review.
F-RT-RELAY-SP	5.60E-01	2.67E-01	RAT RELAY SPURIOUS PROBABILITY	Addressed in the Level 1 Fire Importance Review.
1CTSYLRGPCFLLR--	2.00E-01	2.25E-01	CONT. CATASTROPHIC FAILURE MODE	Addressed in the Level 1 Fire Importance Review.
1CVMV-FAILOP-F--	1.00E+00	2.19E-01	MOTOR OPERATED VALVE FC007 CLOSES	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CTSYSTEAMBIND--	2.04E-01	2.17E-01	CONT. RUPTURE RAPIDLY DEPRESSURIZES CONT. CAUSING ST. BINDING	Addressed in the Level 1 Fire Importance Review.
%F_A-2K_1AP06E_H_Y2	1.10E-04	1.64E-01	Fire at 4.16kV MVSG 1AP06E (HEAF) - ZOI 2	Addressed in the Level 1 Fire Importance Review.
%F_A-2N_1AP07E_E_G	2.24E-04	1.33E-01	Fire at 4.16kV MVSG 1AP07E (non-HEAF) - FIS Only	Addressed in the Level 1 Fire Importance Review.
1SXOP-RXSWINJH-F	1.00E+00	1.26E-01	OPERATOR FAILS TO INITIATE SX INJECTION THROUGH RHR DISCHARGE LINE B - FIRE PRA	Addressed in the Level 1 Fire Importance Review.
1FPOPALIGN-FPH-F	1.00E+00	1.25E-01	OPERATORS FAIL TO ALIGN FIRE PROTECTION SYSTEM FOR INJECTION - FIRE PRA VERSION	Addressed in the Level 1 Fire Importance Review.
%F_A-2K_1AP06E_H_O	8.22E-05	1.23E-01	Fire at 4.16kV MVSG 1AP06E (HEAF) - Beyond ZOI	Addressed in the Level 1 Fire Importance Review.
1OPAD-ALTRNT-F--	1.00E+00	1.19E-01	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). Over 92% are related to sequences LOOP-053 and GTR-024. In these cases, the RCIC fails, but HPCS operates successfully until containment failure leads to loss of RPV injection. Catastrophic containment failure occurs in about 25% of the contributors, but for the remaining contributors, if the fire protection system was hard piped to allow early injection to the RPV (SAMA 10), there would be adequate time to align the FLEX generator for long term DC support (or existing Blackstart capabilities could be used), SRV operation, and RPV makeup could be maintained. With regard to containment venting failures (96%), these contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems(SAMA 4), and about 31% contributors could be addressed by providing procedure enhancement to use existing equipment to provide power support to containment vent components (SAMA 12).

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-PRESBK-F--	8.00E-01	1.19E-01	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not caused by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	8.10E-01	1.19E-01	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	3.00E-01	1.19E-01	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1DGDG-DG01KB-M--	9.48E-03	1.02E-01	DG01KB OUT OF SERVICE MAINTENANCE	Addressed in the Level 1 Fire Importance Review.
1DGDG-DG01KA-X-F	2.40E-02	8.34E-02	FAILURE OF DIESEL GENERATOR DG01KA TO RUN (FIRE)	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
%F_A-2K_1AP04E_H_O	5.02E-05	7.43E-02	Fire at 6.9kV MVSG 1AP04E (HEAF) - Beyond ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF occurs at 4kv non-safety switchgear 1AP04E and the fire grows beyond the largest analyzed zone of influence (ZOI) and conservatively fails all targets within this zone. This zone is located directly below the Division 1 Switchgear Room (A-2n) and is connected via an open stairwell. Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall and are included in the target set of this HEAF fire. For HEAF events, use of suppression has limited effectiveness, so protection of critical targets would be required to reduce the risk-significance of this initiating event. Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage **(SAMA 27)**.
%F_A-2N_1AP07E_H_Y	8.78E-05	6.91E-02	Fire at 4.16kV MVSG 1AP07E (HEAF) - ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF) occurs at 4kV safety switchgear 1AP07E and fails targets within a zone of influence (ZOI) of 15 feet radius. Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available for non-Division 1 equipment (SAMA 4).
RCVCL-H/E	1.00E+00	6.30E-02	ACCIDENT SEQUENCE H/E	This is a flag that identifies the "High-Early" release category. About 57% of the contributors are CLASS II events (core damage after loss of DHR leads to containment failure). Providing FLEX-like hardened containment vent (SAMA 4) would reduce the risk associated with containment vent failure. Hydrogen deflagration is a 33% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15).

Table 5-2d

CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-II-023	1.00E+00	6.04E-02	ACCIDENT SEQUENCE II-023	This event is a Level 2 model accident sequence tag. The sequence is a loss of containment heat removal scenario that includes a wetwell failure that is above the waterline, the RPV is at high pressure at the time of breach, no energetic drywell or containment failure, and a failure occurs that leads to bypass of the suppression pool (non-scrubbed release). Over 56% of the risk comes from Level 1 scenarios in which high pressure RPV makeup is successful, but containment heat removal systems and containment venting fail, followed by failure of injection after containment failure. Venting failure is generally due to lack of support system availability. These contributors can be mitigated by providing a flex-like hardened containment vent that is straightforward to use and does not rely on other support systems (SAMA 4). Hydrogen deflagration is a 33% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15). Sequence LOOP-085 is a 27% contributor and in these short term SBO scenarios, high pressure injection systems fail early, depressurization is successful, and all low pressure injection systems fail. Providing a hardpiped connection that will allow FPS to be rapidly aligned for RPV makeup would provide an additional means of preventing core damage while the FLEX strategy is implemented (SAMA 10).
RCVCL-1BL	1.00E+00	5.73E-02	ACCIDENT CLASS IBL	Addressed in the Level 1 Fire Importance Review.

Table 5-2d

CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXL26HRPC-H--	1.00E+00	5.63E-02	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 6 HRS IN NODE OP, RX	This event represents the conditional probability that AC power is not restored in time to prevent RPV breach after core damage. About 73% are LOOP-092 sequences in the Level 1 model in which RCIC operates in the short term, but the long term RCIC FLEX strategy fails and RPV depressurization fails. About 21% of the contributors are LOOP-078 sequences that also include successful initial RCIC operation, but depressurization is successful followed by failure of the low pressure injection systems. In the cases, the existing capabilities would support SRV operation such that enhancing the fire protection injection capability by installing a hard pipe connection would help prevent core damage as well as reducing the releases by preventing RPV breach (SAMA 10). Hydrogen deflagration is a 27% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15).
1DGDG-DG01KB-A--	5.06E-03	5.47E-02	FAILURE OF DIESEL GENERATOR 01KB TO START	This event represents the failure to start of EDG 1B. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators.

Table 5-2d

CPS Fire Level 2 High-Early/High-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-OP5-NOTFSU-F	8.10E-01	5.15E-02	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBL) (FIRE)	This event represents the successful depressurization after core damage. The contributors leading to sequences that include scenarios in which RCIC operated for a short term, failed to provide long term makeup, and either depressurization failed or low pressure injection failed after successful depressurization. In general, fire induced failures lead to loss of power to the SRVs and depressurization is failed. However, CPS has Blackstart capabilities that include portable power supplies that can be used to operate the SRVs as well as procedural allowance to use the FLEX generators to support the chargers when normal power is lost; however, these capabilities are not modeled. In the cases, the existing capabilities would support SRV operation such that enhancing the fire protection injection capability by installing a hard pipe connection would help prevent core damage as well as reducing the releases by preventing RPV breach (SAMA 10). Over 84% of the scenarios include the failure of containment venting and the inability of the small diameter vent paths to provide venting capability (1CVPH-SMALLD-F--) after failure of the normal vent path followed by loss of injection, which is addressed by providing FLEX-like hardpiped containment vent (SAMA 4). Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 29% and 23% contributors, respectively. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Hydrogen deflagration is a 27% contributor and is generally included in LOOP scenarios in which power is not available to the igniters. Providing a battery backup supply for the igniters would reduce the risk of uncontrolled hydrogen burns (SAMA 15).
1APRXOSP6HRPCH--	1.00E+00	5.02E-02	FAILURE TO RECOVER OSP WITHIN 6 HOURS (PLANT CENTERED)	Addressed in the Level 1 Fire Importance Review.

Table 5-2e

CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVCL-M/E	1.00E+00	1.00E+00	ACCIDENT SEQUENCE M/E	This is a flag that identifies the "Medium-Early" release category. Over 99% of the contributors include failure to prevent RPV breach (probability 1.0) even though over 85% of the contributors include successful RPV depressurization. Fire protection injection is not credited to prevent RPV breach and in some cases it may already be able to prevent vessel breach, but if the FPS connection was hard-piped to reduce alignment time and allow greater flow, the risk of RPV breach and M/E releases could potentially be reduced (SAMA 10). Independence from the existing service water injection path would increase the benefit of this SAMA given that fire induced failures lead to failure of SW injection in many cases. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 76% and 67% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Independent failures of the EDGs are also large contributors (e.g., EDG B is a 50% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).
1—SYAVAILFAC---	9.35E-01	1.00E+00	PLANT AVAILABILITY FACTOR	Addressed in the Level 1 Fire Importance Review.
RXF	1.00E+00	1.00E+00	FAILURE OF RX (OP=F OR CLASSES IBE, IIID, AND IV)	This event represents the failure to prevent RPV breach given failure to depressurize the RPV in both the pre and post core damage time frames. The description indicates that RPV depressurization has failed, but the important sequences indicate that RPV depressurization is successful in the dominant contributors. Over 85% of the contributors include successful depressurization of the RPV before breach. Providing a hard piped connection to fire protection to allow rapid alignment and injection could potentially reduce the consequences of these scenarios (SAMA 10) by preventing RPV breach. Independent failures of the EDGs are also large contributors (e.g., EDG B is a 50% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVCL-1BE	1.00E+00	9.67E-01	ACCIDENT CLASS IBE	Addressed in the Level 1 Fire Importance Review.
1APRXL218HRPCH--	1.00E+00	9.64E-01	COND. PROB. OF FAILURE TO RESTORE AC IN L2 WITHIN 18 HR IN NODE SI	This event represents the conditional probability that AC power is not restored in time to prevent drywell failure after core damage. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are 63% LOOP-099 sequences and 31% LOOP-085. In these sequences, RCIC, HPCS, and either depressurization or low pressure injection fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup, the risk from these scenarios would be reduced. In addition, 29% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). About 87% of the contribution includes successful depressurization after core damage, yet RX is assumed to be failed. SAMA 10 would also reduce the risk from these scenario.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
F-L2-CIV	1.00E+00	9.64E-01	FIRE FLAG FOR LEVEL 2 CONT ISOL VALVE FAILURE	This event is a flag that marks cases in which one or more containment isolation valves has failed to isolate. 100% are early SBO scenarios in which there is no power to support the containment isolation function, which are 100% LOOP-099 and LOOP-085 sequences. In these sequences, RCIC, HPCS, and either depressurization or low pressure injection fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup, the risk from these scenarios would be reduced. In addition, 29% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 79% and 69% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Independent failures of the EDGs are also large contributors (e.g., EDG B is a 50% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

Table 5-2e

CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-OP7-NOTFSU-F	8.70E-01	8.45E-01	SUCCESSFUL RPV DEPRESSURIZATION (CLASS IBE) (FIRE)	This event represents the probability that RPV depressurization occurs before vessel breach. Over 95% of the contribution containing this event is associated with the LOOP-099 and LOOP-085 sequences. In these sequences, RCIC, HPCS, and either depressurization or low pressure injection fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup (SAMA 10), the risk from these scenarios would be reduced. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 79% and 71% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Independent failures of the EDGs are also large contributors (e.g., EDG B is a 50% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20). In addition, about 27% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-IBE1-063	1.00E+00	8.42E-01	ACCIDENT SEQUENCE IBE1-063	This is the accident sequence IBE-063 flag. In this sequence, the RPV is depressurized before RPV breach, but injection fails to prevent RPV breach. There is no energetic containment failure, but there are both containment and drywell isolation failures as well as failure of containment spray and containment failure due to lack of injection. 100% of the contribution containing this event is associated with the LOOP-099 and LOOP-085 sequences. In these sequences, RCIC, HPCS, and either depressurization or low pressure injection fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup (SAMA 10), the risk from these scenarios would be reduced. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 79% and 71% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Independent failures of the EDGs are also large contributors (e.g., EDG B is a 50% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20). In addition, about 27% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2).
F-ET-RELAY-SP	5.60E-01	7.60E-01	ERAT RELAY SPURIOUS PROBABILITY	Addressed in the Level 1 Fire Importance Review.
F-RT-RELAY-SP	5.60E-01	6.72E-01	RAT RELAY SPURIOUS PROBABILITY	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APRXOSP30MPCH--	1.00E+00	6.59E-01	FAILURE TO RECOVER OSP WITHIN 30 MIN. (PLANT CENTERED)	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-LOOP-099	1.00E+00	6.15E-01	ACCIDENT SEQUENCE LOOP-099	Addressed in the Level 1 Fire Importance Review.
1DGRXDGREC30MH--	1.00E+00	4.79E-01	FAILURE TO RECOVER FAILED DIESEL IN ONE-HALF HOUR	Addressed in the Level 1 Fire Importance Review.
RCVSEQ-LOOP-085	1.00E+00	3.53E-01	ACCIDENT SEQUENCE LOOP-085	Addressed in the Level 1 Fire Importance Review.
%F_CB-5A_1E22-S004_H_O	1.10E-04	3.37E-01	Fire at 4.16kV MVSG 1E22-S004 (HEAF) - Beyond ZOI	Addressed in the Level 1 Fire Importance Review.
1DGDG-DG01KB-X-F	2.40E-02	3.19E-01	FAILURE OF DIESEL GENERATOR 01KB TO RUN (FIRE)	Addressed in the Level 1 Fire Importance Review.
1APRXOSP2HRPCH--	1.00E+00	3.08E-01	FAILURE TO RECOVER OSP WITHIN 2 HOURS (PLANT CENTERED)	Addressed in the Level 1 Fire Importance Review.
1RPRXYDCLOAD-H-F	1.00E+00	1.69E-01	RX: DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL (FIRE VERSION)	Addressed in the Level 1 Fire Importance Review.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1SYRXCB201221H-F	1.00E+00	1.51E-01	RX: OP FAILS TO OPEN RAT/ERAT CB 201 OR CB 221 (FIRE VERSION)	This event represents the failure of the operators to locally open RAT/ERAT circuit breakers that did not automatically open given a loss of an offsite power source when it is used in a dependent action combination. Failure of these circuit breakers to open would prevent the EDG circuit breakers from closing. This action is performed locally in the EDG rooms on the local control panel. The operator would have clear indication of loss of normal power and failure of the EDGs to auto start by the loss of power to the emergency bus. If power is lost, the operators are instructed by EOPs (i.e., EOP-1) to restore power by manually starting the EDGs. The compelling signal would be loss of lighting in the control room plus the lack of voltage on the emergency bus, which occurs at the time of the loss of power event. The action is a routine part of operating crew training and therefore, it has a high probability of success that they would follow through on the action during an actual loss of power event. Therefore, no specific insights have been identified related to this specific action. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 99% and 37% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). In addition, over 99% of the contribution includes load shed failure, which leads to loss of DC power before the FLEX generator can be aligned. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2).
%F_A-2N_1AP07E_H_O	3.61E-05	1.44E-01	Fire at 4.16kV MVSG 1AP07E (HEAF) - Beyond ZOI	This event represents the initiating event in which a high energy arcing fault (HEAF) occurs at 4kV safety switchgear 1AP07E and the fire grows beyond the largest analyzed zone of influence (ZOI) and conservatively fails all targets within this zone. Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available for non-Division 1 equipment (SAMA 4).

Table 5-2e

CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
FDEPGROUP-COMB0001	2.59E-02	1.34E-01	FIRE HRA DEPENDENCY GROUP 0001	This event represents the joint failure of HFEs 1RPOPYDCLOAD-H-F (load shed failure) and 1SYOPCB201221H-F (failure to open breakers to the RAT/ERAT on the DG bus). A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Event 1SYOPCB201221H-F (as 1SYRXCB201221H-F) is addressed above.
1OPAD-ALTRNT-F--	1.00E+00	1.28E-01	ALTERNATE DEPRESS. METHODS NOT CREDITED	This event represents the probability that alternate RPV depressurization methods are not available when the SRVs and main condenser are not available (1.0 for CPS). Over 99% are related to sequence LOOP-099. In these sequences, RCIC, HPCS, and depressurization or fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup (SAMA 10), the risk from these scenarios would be reduced. In 43% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 70% and 54% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). Independent failures of the EDGs are also large contributors (e.g. EDG B is a 40% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1OPPH-PRESBK-F--	8.00E-01	1.28E-01	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	This event represents the probability that a primary system break (i.e., a LOCA) is not cause by a pressure spike during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-SORV---F--	8.10E-01	1.28E-01	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	This event represents the probability that an RPV relief valve does not stick open during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1OPPH-TEMPBK-F--	3.00E-01	1.28E-01	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	This event represents the probability that the RPV, main steam lines, or attached piping do not fail during the post core damage accident evolution such that the RPV is not depressurized by such an event. Event 1OPAD-ALTRNT-F-- is included in all of the same contributors as this event and the same discussion provided for 1OPAD-ALTRNT-F-- is applicable to this event.
1DGDG-DG01KB-M--	9.48E-03	1.17E-01	DG01KB OUT OF SERVICE MAINTENANCE	Addressed in the Level 1 Fire Importance Review.
1RPOPYDCLOAD-H-F	4.63E-01	1.12E-01	DC LOAD SHEDDING PER CPS 4200.01 NOT SUCCESSFUL - FIRE PRA VERSION	This event represents the failure of the operators to perform the DC load shedding task during ELAP scenarios to ensure the DC battery life is adequate to support implementation of FLEX strategies. While the HEP is not large, there are estimated to be 20 minutes available for recover actions after performance in the event an error is made. The difficulty is finding the error with limited personnel. Providing a means and a procedure step to confirm the current draw from the battery is within the expected/acceptable range would help identify if significant load were not properly shed. This could support a checking process improve the reliability of the action (SAMA 2).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
FIRE-TT	1.00E+00	9.34E-02	FIRE INDUCED TURBINE TRIP	This is a flag that indicates that the default initiating event used for the fire PRA is a turbine trip when a more severe initiating event does not apply (i.e., all postulated fire scenarios result in a turbine trip at a minimum). Over 99% are related to sequence LOOP-099. In these sequences, RCIC, HPCS, and depressurization or fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup (SAMA 10), the risk from these scenarios would be reduced. In 49% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). Independent failures of the EDGs are also contributors (e.g., EDG B is a 19% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1APSYLOOPTRAN---	1.71E-03	9.27E-02	TRANSIENT INDUCED LOOP	This event represents the probability of a loss of offsite power given that a plant trip has occurred to a transient event. 100% are related to sequence LOOP-099. In these sequences, RCIC, HPCS, and depressurization or fail leading to subsequent core damage. The current model does not include the Blackstart capabilities, which would support RPV depressurization when other power sources are not available. If this capability was considered with the installation of a hardpiped connection that would allow rapid alignment of the FPS for RPV makeup (SAMA 10), the risk from these scenarios would be reduced. In about 52% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). In over 64% of the scenarios, fire induced failure of the "C" EDG control panel leads to loss of EDG C, and independent failures of the EDGs are also contributors (e.g. EDG B is a 19% contributor counting FTR, FTS, and maintenance unavailability). Installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).
%F_CB-3A_1PL90J_E_G	2.15E-05	8.59E-02	Fire at EP 1PL90J - FIS Only	This event represents the initiating event in which an electrical fire originates at RAT relay panel 1PL90J in the Auxiliary Electric Equipment Room (AEER) and is suppressed early such that the fire does not leave the electrical panel. Given that this initiating event reflects the least severe fire that could originate from this ignition source, no new SAMAs have been identified for this initiating event. However, this initiating event would benefit from SAMA 2 (improved DC load shed procedure) as nearly 80% of the risk associated with this initiating event involves failure of performing DC load shed. Additionally, SAMA 14 (fire wrap of offsite power cables) would also reduce the risk-significance of this initiating event.

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CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
RCVL2-IBE2-054	1.00E+00	8.45E-02	ACCIDENT SEQUENCE IBE2-054	This is a flag event for level 2 containment event tree sequence IBE2-054. The IBE2-054 sequence in the Level 2 model in which depressurization before RPV breach is failed and RPV breach does occur, energetic drywell failure occurs but there is no energetic failure of containment, containment failure due to lack of injection does occur, and containment spray fails. After RPV breach, FPS injection would be available, but it is not credited in the existing configuration. Enhancing the fire protection injection capability by installing a hard pipe connection would further reduce the risk of containment failure (SAMA 10). Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 71% and 54% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14). In about 43% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2).
1DGDG-DG01KB-A--	5.06E-03	6.50E-02	FAILURE OF DIESEL GENERATOR 01KB TO START	This event represents the failure to start of EDG 1B. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). This redundant diesel generator would also mitigate the impact of fire-induced failures of the existing diesel generators. Events F-ET-RELAY-SP and F-RT-RELAY-SP are about 71% and 54% contributors, respectively, which lead to loss of offsite power. Installing 3-hour rated fire cable wrap on the cables that could prevent the fire induced failures throughout their entire cable routing would reduce the risk of these failures (SAMA 14).

Table 5-2e

CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
F-CO2	1.00E+00	6.32E-02	CO2 PANEL FAILURE	This event is a flag event that marks the unavailability of the CO2 panel in a fire event. The fires are MCR fires that fail the panel that controls all of the EDGs. Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events (SAMA 20). In addition, over 78% include successful RPV depressurization before RPV breach. Installing a hard pipe connection between the Fire Protection system and the RHR system to allow rapid alignment of the Fire Protection system to RHR for RPV makeup would allow for credit of this alternate injection method (SAMA 10). In about 29% of the scenarios, DC load shed fails. One approach to reducing the risk of these scenarios would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2).
1DGDG-DG01KA-X-F	2.40E-02	6.12E-02	FAILURE OF DIESEL GENERATOR DG01KA TO RUN (FIRE)	Addressed in the Level 1 Fire Importance Review.

Table 5-2e

CPS Fire Level 2 Medium-Early/Medium-Late Importance List Review

Event Name	Probability	Fus Ves	Description	Potential SAMAs
1CZPH-HPBDVS2F--	5.00E-01	5.28E-02	RPV BLOWDOWN OVERWHELMS VS AND FAILS DW (OP=F)	This event represents the probability that when the RPV fails at high pressure after core damage, the blowdown exceeds the vapor suppression capacity and fails the drywell. Over 42% of the contribution is related to failure of DC load shed. A potential means of improving load shed reliability would be to include a procedure step to confirm the current draw on the station battery is within the expected range after the load shed action as a means of confirming the load shed was performed completely for ELAP conditions (SAMA 2). In addition, CPS blackstart capabilities, which can support SRV operation, are not credited in the model. In about 25% of the scenarios, power is restored to the switchyard, but it cannot be aligned to the emergency buses in time to prevent core damage. A potential enhancement would be to create an emergency connection to the offsite power line that could be quickly aligned to an emergency bus from the MCR (SAMA 5). Independent failures of the EDGs are also contributors (e.g., EDG B is about a 40% contributor counting FTR, FTS, and maintenance unavailability) and installing a diesel generator that can be aligned to any division could help reduce the risks associated with these events (SAMA 20).

Table 5-3
CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
1	Provide Portable HVAC Equipment and Supporting Procedures for Alternate DG Room Cooling	For scenarios involving loss of room cooling for the EDGs, providing a diverse, portable fan/ductwork to indefinitely maintain room temperature in the acceptable range would prevent SBO/loss of 4KV power due to HVAC failures.	FPIE Importance Lists	$399,746 (DEK 2008) Includes room heatup analysis, design changes, addition of high room temp alarms, portable fans, and a procedure change.	Not Used
2	Proceduralize DC Current Check for ELAP Load Shed Action	Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.	FPIE Importance Lists Fire Importance Lists	$50, 000 (Entergy 2017) Estimate for a minor change to a non-EOP procedure with limited training requirements.	Implementation cost is less than MACR. Retain for Phase II analysis
3	Protect the RCIC Storage Tank, Provide Long Term Makeup, and Support Containment Venting for Heat Removal	While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control (procedure changes to use FLEX generator assumed to be required in some cases) would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.	FPIE Importance Lists	$8,915,554 (S&L 2023) CPS-specific cost estimate for installing a pre-cast concrete enclosure similar to the FLEX storage building, with thicker panels, attached to the Fuel Building west wall, and mounted on new footings.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
4	Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.	FPIE Importance Lists Fire Importance Lists	$12.94 million (Exelon 2014) This LaSalle estimate does not include contingency costs.	Implementation cost is greater than MACR. Screened from Phase II analysis
5	Install an Emergency Tie Line From the Switchyard to an Emergency Bus	The process to restore offsite AC power to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.	FPIE Importance Lists	$400,000 (WCN 2006) Wolf Creek estimated the cost of providing the MCR with the capability of remotely aligning a local generating station to the site. This is considered to be similar in scope to the CPS SAMA and it has been used as an approximation of the cost.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
6	Provide Flood Protection for MCR HVAC Ducts	A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.	FPIE Importance Lists	$475,000 (SNC 2003) Farley estimated the cost of sealing MCCs in the cable spreading room to protect them from flood water intrusion - this is used as an approximation for sealing the MCR room cooler units and ducts.	Implementation cost is less than MACR. Retain for Phase II analysis
7	Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose NPSH and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.	FPIE Importance Lists	$250,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $200,000 to $300,000 for procedure changes that include engineering support and operator testing/training to implement, which is consistent with an EOP change for controlling containment pressure to maintain NPSH and protect containment integrity.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
8	Replace the Inboard Containment Vent AOV with an Environmentally Qualified Valve	A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.	FPIE Importance Lists	$1.828,302 (S&L 2023) CPS-specific cost estimate for valve replacement of the inboard containment isolation valve.	Implementation cost is less than MACR. Retain for Phase II analysis
9	Install Keylock Switch to Override MSIV Low RPV Level Isolation Logic	For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level MSIV isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly. Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.	FPIE Importance Lists	$635,242 (Exelon 2014)	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3
CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
10	Install a Hard Piped Connection to Allow Rapid Alignment of FPS for RPV Makeup	Currently, the FPS can be used to inject to the RPV, but it requires significant manual work and time to perform the alignment. The availability of a hard piped connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations. Ensuring it is diverse from the existing service water cross-tie and/or ensuring it can be aligned without support systems would maximize benefit. Use of this SAMA should include maintaining RPV level while the FLEX generator was aligned in ELAP scenarios.	FPIE Importance Lists Fire Importance Lists	$649,194 (Exelon 2014)	Implementation cost is less than MACR. Retain for Phase II analysis
11	Replace Valves with Versions Designed to Close Against High Flow and Differential Pressure	The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.	FPIE Importance Lists	$600,000 (WCN 2006) The estimate includes replacing two MOVs with improved versions for ISLOCA isolation.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
12	Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed as supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power. A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.	FPIE Importance Lists	$100,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $50,000 to $200,000 for procedure changes that include engineering support or operator testing/training to implement, which is consistent with a procedure change for identifying conditions that would require use of the FLEX generator for conditions specific to containment vent support.	Implementation cost is less than MACR. Retain for Phase II analysis
13	Alternate ECCS Pump Room Cooling	For scenarios involving loss of room cooling to the ECCS pump rooms, perform a room heatup analysis to identify what equipment capabilities would be needed to prevent pump damage on overtemperature given loss of all room cooling (including fans). Provide diverse, portable fan/ductwork that would meet these requirements and maintain room temperature in the acceptable range to allow indefinite operation of the pumps after failure of the normal HVAC system.	FPIE Importance Lists Fire Importance Lists	$399,746 (DEK 2008) Includes room heatup analysis, design changes, addition of high room temp alarms, portable fans, and a procedure change.	Not Used

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
14	Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.	Fire Importance Lists	$5,629,397 (S&L 2023) CPS-specific cost estimate for protecting cable runs for the ERAT and RAT from the transformers to the protective relay panels, and to the emergency bus feeder breakers.	Implementation cost is less than MACR. Retain for Phase II analysis
15	Install a Battery Backup to the Hydrogen Igniters	While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.	FPIE Importance Lists Fire Importance Lists	$352,000 (S&L 2023) CPS-specific cost estimate for providing a battery backup to each of the two hydrogen igniter distribution panels.	Implementation cost is less than MACR. Retain for Phase II analysis
16	Squib Valve Bypass Line	Failure of the explosive valves in the SLC injection pathway (squib valves) leads to loss of the ability inject liquid poison in the reactor in a timely manner. Providing a bypass line that includes MOVs would provide a diverse injection pathway.	FPIE Level 2 Importance List	$716,477 (S&L 2023) CPS-specific cost estimate for installing a new 1 ½ safety related bypass line with a single isolation valve that bypasses the A and B division Squib valves.	Not Used

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
17	Protect the Equipment Required for SRV Operation in the Aux. Building	In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.	FPIE Level 2 Importance List	$701,000 (S&L 2023) This CPS-specific cost estimate addresses the replacement of the outboard containment isolation valves on the IA lines, which is only a subset of the changes required to completely protect the equipment in the Aux Building to maintain SRV operability. Because the cost of this subset of the overall scope obviously exceeded the benefit for this SAMA, the work to address the remaining scope of the SAMA was not pursued..	Implementation cost is less than MACR. Retain for Phase II analysis
18	Install an Emergency RCIC Storage Tank Makeup Capability from Service Water Operable from the MCR	For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a CST makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.	FPIE Level 2 Importance List	$2,900,000 (Exelon 2014) LaSalle estimated the cost of providing a connection from RHRSW to the Core Spray system with remotely operated MOVs. This is considered to be similar in scope to the CPS SAMA with the major difference being that the makeup line goes to the RCIC storage tank rather than LPCS.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
19	Modify FLEX Procedure for FPS Makeup to the RCIC Storage Tank to Allow Use in Non-ELAP Scenarios	For cases in which SP cooling is not available or in some LOCA scenarios, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RPV makeup indefinitely.	FPIE Importance Lists	$100,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $50,000 to $200,000 for procedure changes that include engineering support or operator testing/training to implement, which is consistent with a procedure change for identifying conditions that would require use of the FLEX pumps for non-ELAP conditions.	Implementation cost is less than MACR. Retain for Phase II analysis
20	Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.	FPIE Importance Lists Fire Importance Lists	$8,000,000 (NMC 2008)	Implementation cost is less than MACR. Retain for Phase II analysis
21	Address Flow FW Diversion in the Loss of Instrument Air Procedure	Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.	Industry SAMA list	$30,000 (CEG 2004)	Implementation cost is less than MACR. Retain for Phase II analysis
22	Upgrade the alternate shutdown panel to include additional system control for the opposite division	The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.	Industry SAMA list	$790,000 (Entergy 2017)	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3
CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
23	Automatic ATWS Level Control System	For failure to scram conditions, early reduction in RPV level is important to limit the heat load sent to the containment, the reliability of which could be improved by automating select ATWS response actions. The logic would be required to actuate without operator interface, only actuate when the Feedwater system is available and providing makeup to the RPV, and automatically 1) reduce RPV level to the control band specified in the EOPs, 2) inhibit ADS, and 3) "terminate and prevent injection" from non-Feedwater injection systems. This would increase the time available for the operators to perform the other actions required early in ATWS scenarios, such as MSIV low level isolation logic bypass and SLC injection.	FPIE Importance Lists	$1,481,002 (Exelon 2014) LaSalle provided a plant-specific cost estimate for this SAMA in 2014.	Implementation cost is less than MACR. Retain for Phase II analysis
24	Proceduralize Use of the FLEX Generator to Supply Station Battery Chargers in Non-ELAP Scenarios	CPS already has procedures and equipment to use portable DC supplied to support SRV operation, if required, but a potential enhancement to provide long term power would be to direct alignment of the FLEX generator in non-ELAP scenarios.	FPIE Importance Lists	$100,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $50,000 to $200,000 for procedure changes that include engineering support or operator testing/training to implement, which is consistent with a procedure change for identifying conditions that would require use of the FLEX generators for non-ELAP conditions.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
25	Develop Flood Area-Specific Response Procedures	The current flood mitigation strategy relies heavily on operators to identify flood sources and to devise mitigation strategies in an ad-hoc manner. The development of procedures to help the operators systematically review indications to identify flood sources and that provide isolation strategies would potentially improve the reliability of the flooding response actions.	FPIE Importance Lists	$115,000 (Exelon 2014) LaSalle provided a plant-specific cost estimate for this SAMA in 2014.	Implementation cost is less than MACR. Retain for Phase II analysis
26	Include Explicit Steps in the Loss of AC Power Procedure to Address Water Hammer	CPS currently has ARPs that can help operators identify conditions when the ECCS and SX discharge piping is drained and there are steps included that can help prevent water hammer events, but providing explicit steps in the Loss of AC Power procedure would make the required steps more visible and potentially improve the reliability of the action.	Fire Importance Lists	$250,000 (Entergy 2017) The River Bend SAMA analysis used an implementation cost range of $200,000 to $300,000 for procedure changes that include engineering support and operator testing/training to implement, which is consistent with an EOP change for to add priority steps to the Loss of AC Power procedure to prevent water hammer.	Implementation cost is less than MACR. Retain for Phase II analysis
27	Fire Wrap / Fire Barrier Around Critical Cable Risers in Fire Zone A-2k	Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall of Fire Zone A-2k (non-safety switchgear room). These cable risers are critical targets within this Fire Zone. Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage	Fire Importance Lists	$1,121,838 (APS 2009) Palo Verde estimated costs of $1.21 million to protect specific cables in a fire compartment and $5.65 million for all cables related to a specific pump in 4 different areas. The scope of the CSP enhancement is more closely related to protecting selected cables in one area and the $1.21 million cost is used.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 5-3

CPS Phase 1 SAMA List Summary

SAMA #	SAMA Title	Description	Source	Cost Estimate (per unit)	Phase 1 Baseline Disposition
28	Rerouting of conduits C0734 and C0818 from Fire Zone CB-5a to CB-1g	The Division 3 Switchgear Room (CB-5a) is located south of the Division 1 Cable Spreading Room (CB-4) in the Control Building. Conduits C0734 and C0818, which support Division 1 equipment, are routed through CB-5a before they enter Fire Zone CB-5c. Rerouting these conduits through Fire Zone CB-1g, which is east of both CB-5a and CB-4 would reduce the risk-significance of fires originating in CB-5a.	Fire Importance Lists	$3,250,000 (WCN 2006) Wolf Creek estimated the cost of re-routing cables around ignition sources to be $3.25 million. For CPS, multiple cables must be rerouted around an entire room, which is an effort that is similar in scope to the Wolf Creek enhancement.	Implementation cost is less than MACR. Retain for Phase II analysis

Table 6-1

CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
1	Provide Portable HVAC Equipment and Supporting Procedures for Alternate DG Room Cooling	For scenarios involving loss of room cooling for the EDGs, providing a diverse, portable fan/ductwork to indefinitely maintain room temperature in the acceptable range would prevent SBO/loss of 4KV power due to HVAC failures.	FPIE Importance Lists	Not Used
2	Proceduralize DC Current Check for ELAP Load Shed Action	Providing a step in the load shed procedure to check the current on the station battery/batteries to confirm it is within the expected range would provide a means of recovering any critical load shed omissions and potentially improve the reliability of the load shed action.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
3	Protect the RCIC Storage Tank, Provide Long Term Makeup, and Support Containment Venting for Heat Removal	While the PRA model includes some conservative assumptions regarding the unavailability of the RCIC storage Tank in long term loss of decay heat removal scenarios (including ELAP), protecting the tank and providing a makeup source that would ensure it would remain available as a long term RCIC suction source would provide an alternate success path to the plant strategies. Providing RCIC with a cool suction source combined with performing containment venting for containment pressure control (procedure changes to use FLEX generator assumed to be required in some cases) would preclude the need to rely on suppression pool cooling for success in long term loss of decay heat removal scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
4	Enhance Containment Venting Capability (e.g., FLEX hardpipe vent)	The CPS FLEX design includes diverse venting means, though there are currently scenarios in which equipment qualifications and support systems may limit operation. Providing a vent path that can operate in the environmentally stressed conditions in which it must be used with means of operating the vent path without the support systems may further reduce plant risk. In addition, ensuring the procedures clearly direct use of the path in emergency conditions and that the operation of the vent path is simple and straightforward will provide additional benefit.	FPIE Importance Lists Fire Importance Lists	This SAMA was screened during Phase 1.

Table 6-1
CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
5	Install an Emergency Tie Line From the Switchyard to an Emergency Bus	The process to restore offsite AC power to the plant safety systems after a loss of offsite power can be time consuming, especially if the duration of the event extends beyond 4 hours and local breaker manipulation is required due to battery depletion. Establishing a more direct tie between the switchyard and the emergency bus(es) that has a dedicated, long term breaker power supply would improve the reliability of power restoration in emergency scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
6	Provide Flood Protection for MCR HVAC Ducts	A major FPS or SX pipe rupture in the MCR HVAC Train areas of CB-1I would accumulate and can leak into the MCR HVAC ducting providing a propagation path to the MCR areas on the floor below. Waterproofing the ductwork and/or providing a rupture panel to divert water prior to entry into critical areas would reduce the risk from MCR flooding scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
7	Enhance Procedures and Operator Training to Include Containment Venting Control for NPSH Management	For long term scenarios in which the RHR system is unable to remove heat from the containment, containment venting may be used to release energy from the containment and to control containment pressure below the primary containment pressure limit. While this provides a potential success path for preserving containment, it can lead to a reduction in containment pressure and when combined with the elevated suppression pool water temperature, the pumps taking suction from the suppression pool may lose NPSH and fail. Providing procedure guidance and training to control containment pressure in band that will both protect containment and support pump operation could reduce plant risk.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
8	Replace the Inboard Containment Vent AOV with an Environmentally Qualified Valve	A significant contributor to the failure of the containment venting function is the failure of the vent valve to operate in adverse containment conditions. A potentially lower cost approach than installing an entire hardpiped vent path would be to help ensure the current valve can operate in adverse conditions.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 6-1

CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
9	Install Keylock Switch to Override MSIV Low RPV Level Isolation Logic	For ATWS scenarios, RPV level reduction to control power is required early in the scenario, and if the operators fail to bypass the low level MSIV isolation logic, the MSIVs will isolate when the proceduralized steps are taken to reduce RPV level. The process to bypass the isolation logic requires work within MCR panels and cannot be performed rapidly. Installing a keylock switch that could bypass the logic in ATWS events could improve the reliability of the bypass action.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
10	Install a Hard Piped Connection to Allow Rapid Alignment of FPS for RPV Makeup	Currently, the FPS can be used to inject to the RPV, but it requires significant manual work and time to perform the alignment. The availability of a hard piped connection between the systems would allow for rapid alignment of FPS for low pressure injection in emergency situations. Ensuring it is diverse from the existing service water cross-tie and/or ensuring it can be aligned without support systems would maximize benefit. Use of this SAMA should include maintaining RPV level while the FLEX generator was aligned in ELAP scenarios.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
11	Replace Valves with Versions Designed to Close Against High Flow and Differential Pressure	The CPS ISLOCA analysis currently does not credit ISLOCA break isolation due to thermal overload leading to loss of the valves when isolation is attempted when there is a large pressure differential across the valves. Replacing the valve that would be used to isolate the break with one qualified to perform the isolation task would provide a means of mitigating the event.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 6-1
CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
12	Modify Plant Procedures to Direct Use of FLEX Generators to Support Containment Venting	The primary FLEX strategy already aligns power to one division of 480V power, but the strategy is not aimed as supporting the containment venting process. A plant procedure also exists that supports venting without AC support power, but it relies on a set of normally open containment isolation motor operated valves remaining open in scenarios with loss of AC power. A potential enhancement would be to direct the use of the portable generators in emergency scenarios when power is not available to support the venting function when the valves have previously closed.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
13	Alternate ECCS Pump Room Cooling	For scenarios involving loss of room cooling to the ECCS pump rooms, perform a room heatup analysis to identify what equipment capabilities would be needed to prevent pump damage on overtemperature given loss of all room cooling (including fans). Provide diverse, portable fan/ductwork that would meet these requirements and maintain room temperature in the acceptable range to allow indefinite operation of the pumps after failure of the normal HVAC system.	FPIE Importance Lists Fire Importance Lists	Not Used
14	Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas	Installation of 3-hour rated fire cable wrap on offsite power cables (specifically those required for the 86 and 286 series relays and the RAT/ERAT feed breakers) throughout their entire cable routing would protect the cables from potential fire-induced failures and ensure that offsite power remains available.	Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
15	Install a Battery Backup to the Hydrogen Igniters	While the FLEX generator is able to supply the buses that power the hydrogen igniters, short term SBO sequences leave the igniters without power. Providing a battery supply that would maintain the igniters until the FLEX generator can be aligned would help reduce the risk of hydrogen deflagration.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 6-1
CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
16	Squib Valve Bypass Line	Failure of the explosive valves in the SLC injection pathway (squib valves) leads to loss of the ability inject liquid poison in the reactor in a timely manner. Providing a bypass line that includes MOVs would provide a diverse injection pathway.	FPIE Level 2 Importance List	Not Used
17	Protect the Equipment Required for SRV Operation in the Aux. Building	In some scenarios, including ATWS events, harsh conditions in the auxiliary building may fail equipment required to depressurize the RPV. Providing protective enclosures or replacing components with types qualified to operate in adverse conditions may reduce the risk from such scenarios.	FPIE Level 2 Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
18	Install an Emergency RCIC Storage Tank Makeup Capability from Service Water Operable from the MCR	For events with long term, high volume RPV injection requirements, such as breaks outside containment, providing a CST makeup capability that can be rapidly aligned from within the MCR would enhance the plant's ability to mitigate such events. This approach provides this capability without impacting the way the plant currently maintains the breaker governing the SW to RHR cross-tie valve. In addition, it provides a long term injection source that does not rely on the RHR injection path.	FPIE Level 2 Importance List	This SAMA's net value is negative and is classified as not "cost-beneficial".
19	Modify FLEX Procedure for FPS Makeup to the RCIC Storage Tank to Allow Use in Non-ELAP Scenarios	For cases in which SP cooling is not available or in some LOCA scenarios, the RCIC storage tank volume is not adequate for long term cooling requirement. Enhancing the normal makeup capability by changing the FLEX procedure such that it can be used in non-ELAP scenarios would provide a means of maintaining RPV makeup indefinitely.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
20	Additional diesel generator that can act as a swing diesel generator to all divisions of AC Power	Installation of an additional diesel generator to act as a swing diesel generator to all divisions of AC power would mitigate the impact of a failed diesel generator during loss of offsite power events.	FPIE Importance Lists Fire Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 6-1
CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
21	Address Flow FW Diversion in the Loss of Instrument Air Procedure	Loss of instrument air leads to the minimum flow valves on the FW pumps to fail open, which results in a flow diversion back to the hotwell that is assumed to preclude adequate RPV injection. Enhancing the loss of instrument air procedure to explicitly address this condition could help restore Condensate/FW capability more efficiently.	Industry SAMA list	This SAMA's net value is negative and is classified as not "cost-beneficial".
22	Upgrade the alternate shutdown panel to include additional system control for the opposite division	The CPS remote shutdown panel does not currently provide control of both divisions of plant equipment. Providing the ability to operate both divisions of equipment could mitigate some MCR abandonment scenarios.	Industry SAMA list	This SAMA's net value is negative and is classified as not "cost-beneficial".
23	Automatic ATWS Level Control System	For failure to scram conditions, early reduction in RPV level is important to limit the heat load sent to the containment, the reliability of which could be improved by automating select ATWS response actions. The logic would be required to actuate without operator interface, only actuate when the Feedwater system is available and providing makeup to the RPV, and automatically 1) reduce RPV level to the control band specified in the EOPs, 2) inhibit ADS, and 3) "terminate and prevent injection" from non-Feedwater injection systems. This would increase the time available for the operators to perform the other actions required early in ATWS scenarios, such as MSIV low level isolation logic bypass and SLC injection.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
24	Proceduralize Use of the FLEX Generator to Supply Station Battery Chargers in Non-ELAP Scenarios	CPS already has procedures and equipment to use portable DC supplied to support SRV operation, if required, but a potential enhancement to provide long term power would be to direct alignment of the FLEX generator in non-ELAP scenarios.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 6-1

CPS Phase 2 SAMA List Summary

SAMA #	SAMA Title	SAMA Description	Source	Phase 2 Baseline Disposition
25	Develop Flood Area-Specific Response Procedures	The current flood mitigation strategy relies heavily on operators to identify flood sources and to devise mitigation strategies in an ad-hoc manner. The development of procedures to help the operators systematically review indications to identify flood sources and that provide isolation strategies would potentially improve the reliability of the flooding response actions.	FPIE Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".
26	Include Explicit Steps in the Loss of AC Power Procedure to Address Water Hammer	CPS currently has ARPs that can help operators identify conditions when the ECCS and SX discharge piping is drained and there are steps included that can help prevent water hammer events, but providing explicit steps in the Loss of AC Power procedure would make the required steps more visible and potentially improve the reliability of the action.	Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
27	Fire Wrap / Fire Barrier Around Critical Cable Risers in Fire Zone A-2k	Several Division 1 cable risers (16R9, 16R10, 16R19, 16R20, & 16R21) are located on the east wall of Fire Zone A-2k (non-safety switchgear room). These cable risers are critical targets within this Fire Zone. Installation of a 3-hour rated fire barrier / fire wrap around these cable risers would protect these cables from fire-induced damage	Fire Importance Lists	This SAMA's net value is positive and is classified as potentially "cost-beneficial".
28	Rerouting of conduits C0734 and C0818 from Fire Zone CB-5a to CB-1g	The Division 3 Switchgear Room (CB-5a) is located south of the Division 1 Cable Spreading Room (CB-4) in the Control Building. Conduits C0734 and C0818, which support Division 1 equipment, are routed through CB-5a before they enter Fire Zone CB-5c. Rerouting these conduits through Fire Zone CB-1g, which is east of both CB-5a and CB-4 would reduce the risk-significance of fires originating in CB-5a.	Fire Importance Lists	This SAMA's net value is negative and is classified as not "cost-beneficial".

Table 7.3-1

WinMACCS Decontamination Parameter Inputs

Variable	Description	Base Case Values	NUREG/CR-7270 Sensitivity Values(1)
EVACST	Daily cost for a person who has been evacuated ($/person-day)	261	271
RELCST	Daily cost for a person who is relocated ($/person-day)	261	191
POPCST	Population relocation cost ($/person)	18,204	9,703
LVLDEC	Number of decontamination levels	2	3
CDFRM	Cost of farm decontamination for levels of decontamination ($/hectare)	DRF3(2): 2,018 DRF15: 4,490	DRF2: 4,773 DRF4: 49,020 DRF8: 49,020
TIMDEC	Decontamination time for each level	DRF3: 60 days DRF15: 120 days	DRF2: 1 yr DRF4: 1yr DRF8: 1yr
CDNFRM	Cost of non-farm decontamination per resident person for levels of decontamination ($/person)	DRF3: 10,786 DRF15: 28,823	DRF2: 100,000(3) DRF4: 100,000 DRF8: 100,000
DLBCST	Average cost of decontamination labor ($/man-year)	127,428	98,040
TFWKF	Fraction of time workers spend in farm land contaminated areas	DRF3: 0.10 DRF15: 0.33	DRF2: 0.15 DRF4: 0.15 DRF8: 0.15
TFWKNF	Fraction of time workers spend in non-farm land contaminated areas	DRF3: 0.33 DRF15: 0.33	DRF2: 0.15 DRF4: 0.15 DRF8: 0.15
FRFDL	Fraction of farm decontamination cost due to labor	DRF3: 0.30 DRF15: 0.35	DRF2: 0.35 DRF4: 0.35 DRF8: 0.35
FRNFDL	Fraction of non-farm decontamination cost due to labor	DRF3: 0.70 DRF15: 0.50	DRF2: 0.35 DRF4: 0.35 DRF8: 0.35

1 NUREG/CR-7270 based costs are escalated to July 2022 using the CPI, similar to that done for the base case.

2 DRF is a dose reduction (decontamination) factor. A DRF of 3 reduces the dose to 33% of the original value. DRF15 is a dose reduction factor of 15 (reduction to 6.7%).

3 The NUREG/CR-7270 values are $78,000, $180,000, and $270,000 for DRFs of 2, 4, and 8, respectively, in 2012 dollars. WinMACCS version 3.10 has an input limit of $100,000 for variable CDNFRM. NUREG/CR-7270 recommends that for such cases 100,000 be used as the input.

10.0 FIGURES

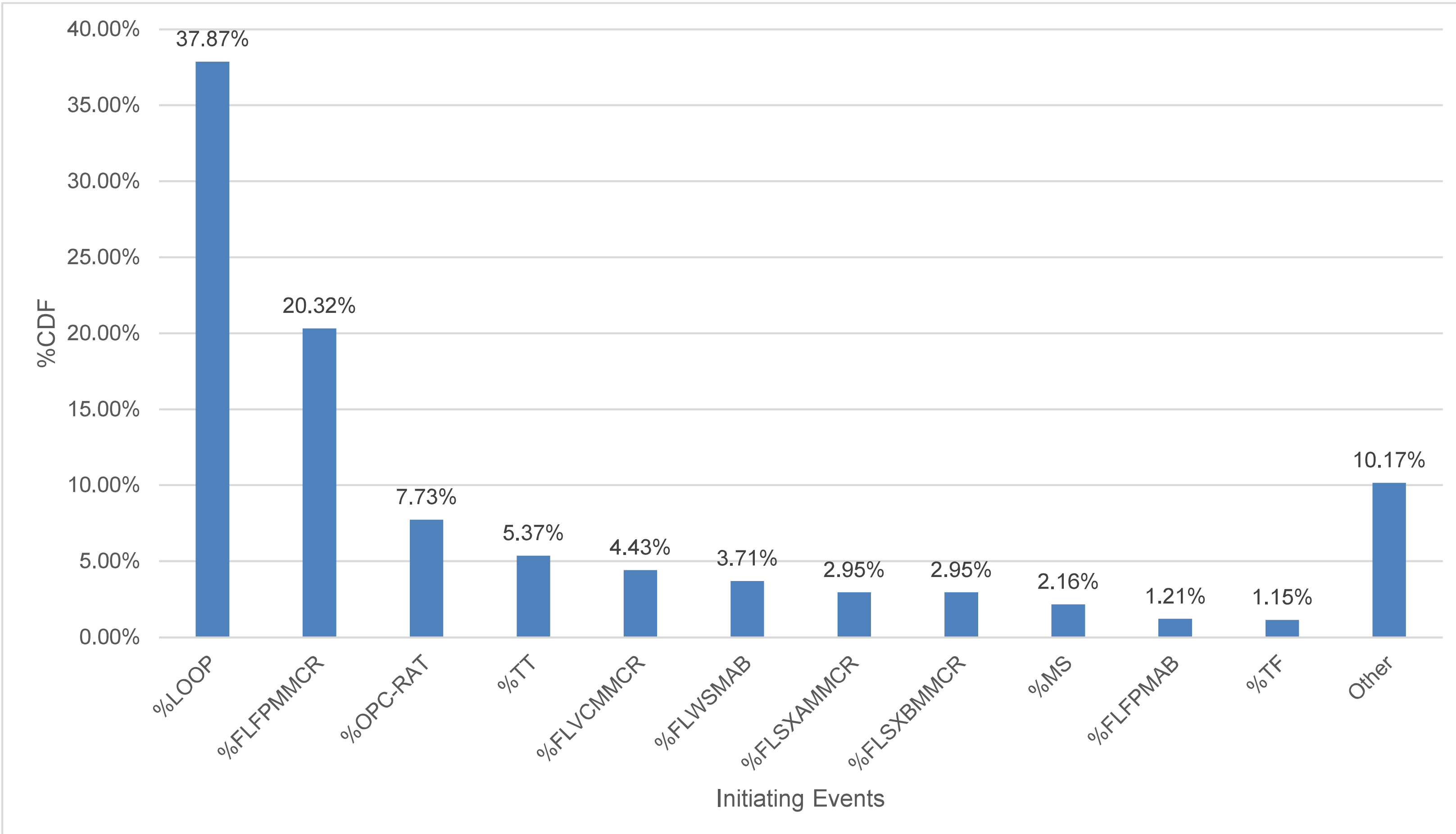

Figure 2.3.1-1

Clinton FPIE CDF Results by Initiating Event

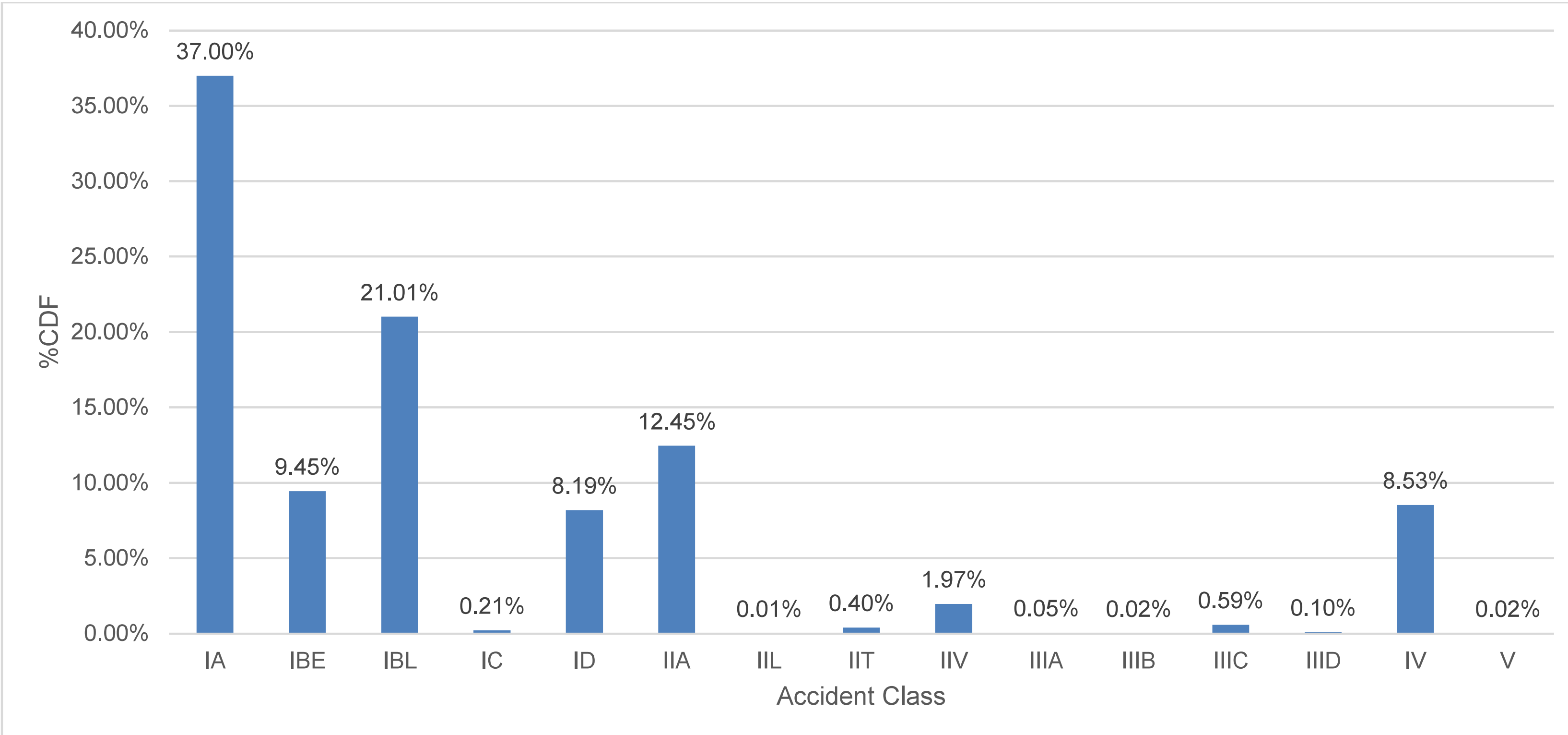

Figure 2.3.1-2

Clinton FPIE CDF Results by Accident Class

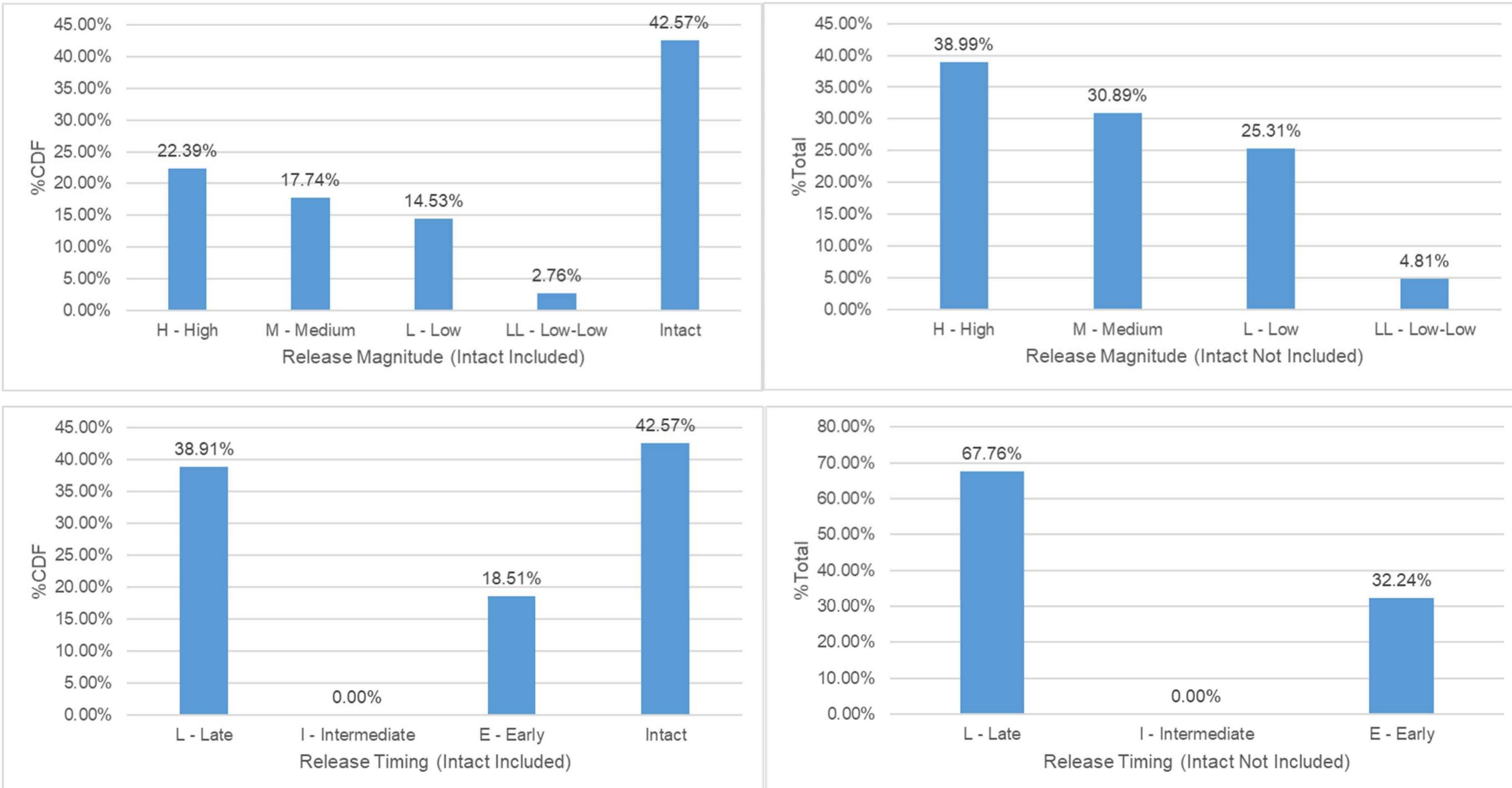

Figure 2.3.2-1

Clinton FPIE Level 2 Results by Radionuclide Release Timing

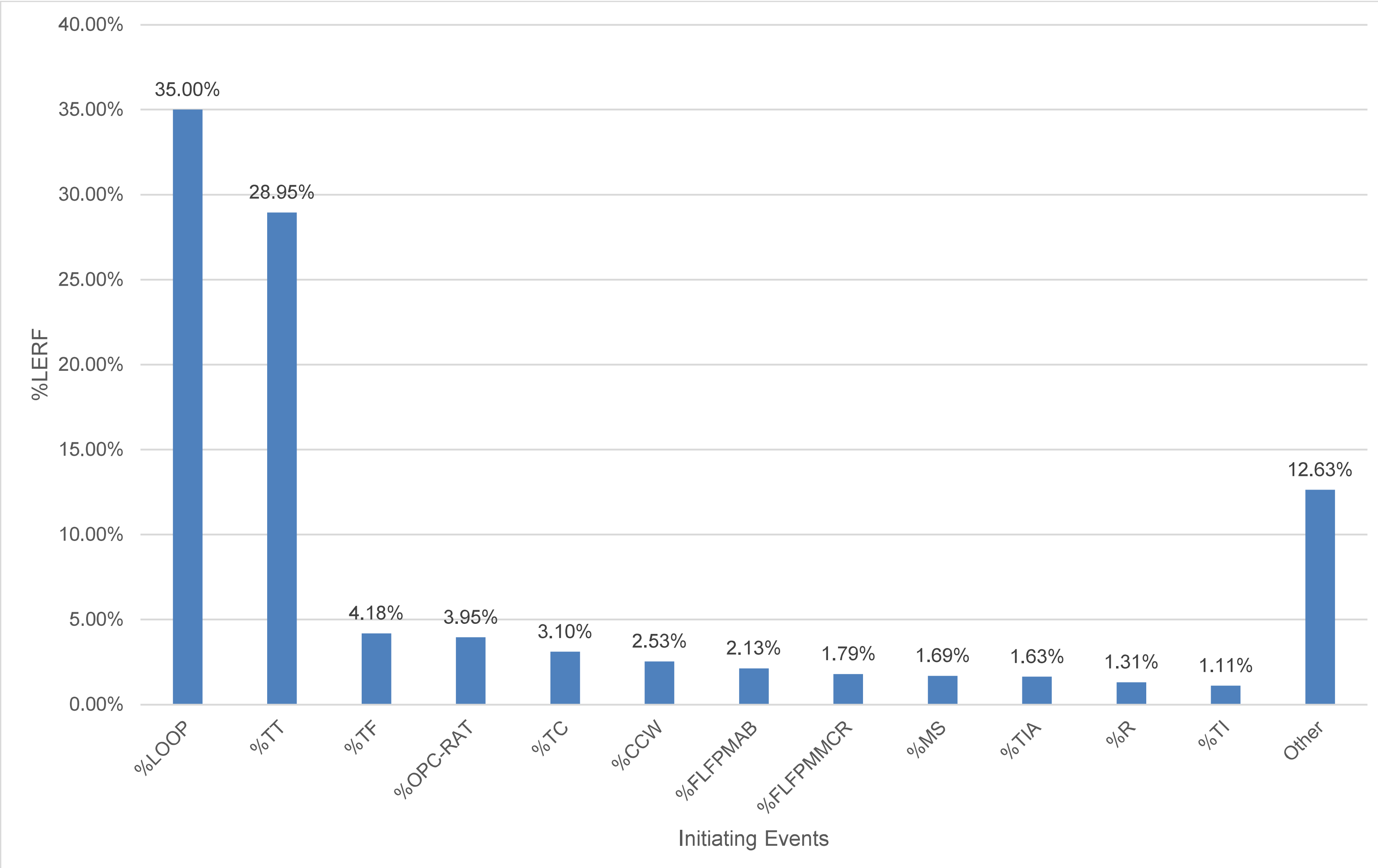

Figure 2.3.2-2

Clinton FPIE LERF Results by Initiating Event

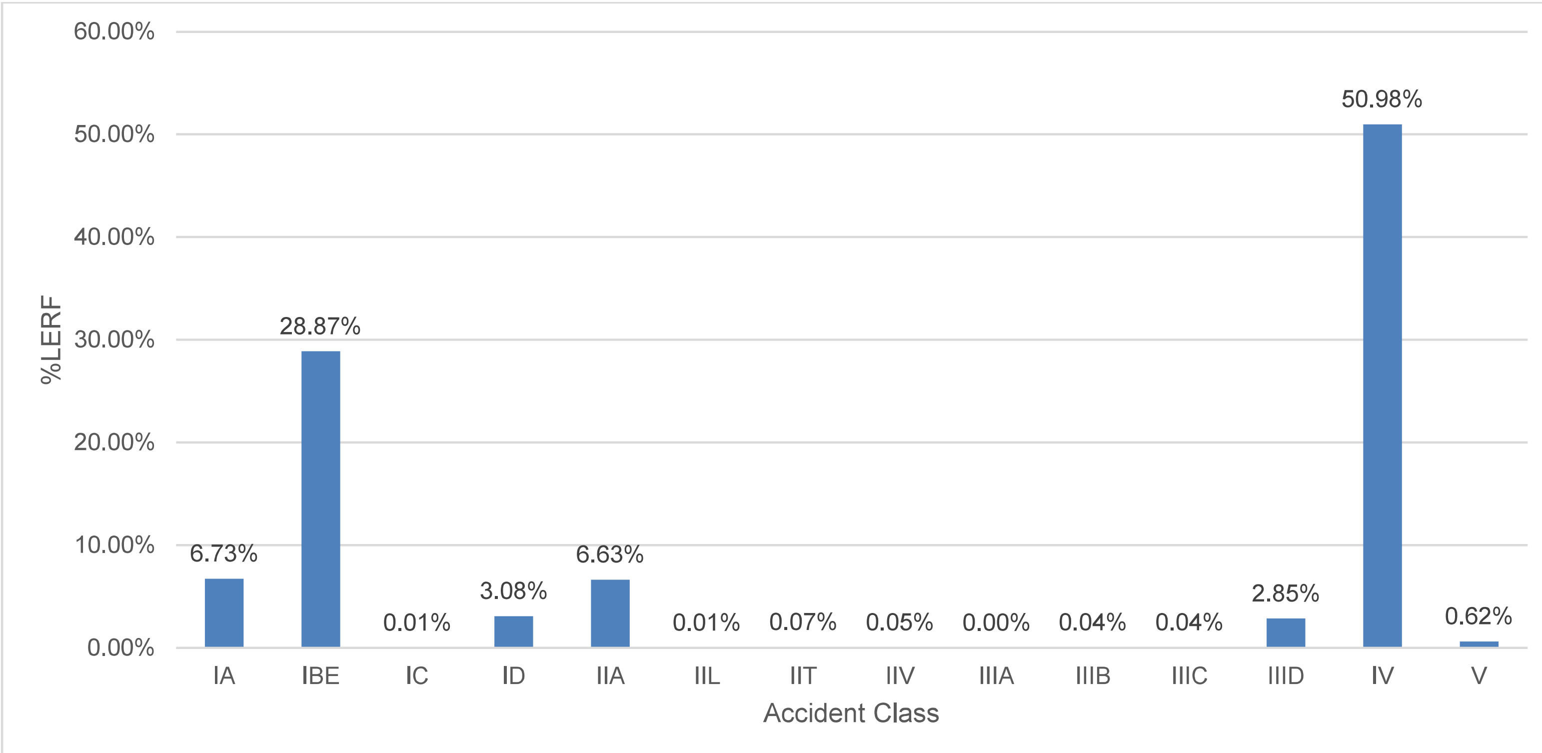

Figure 2.3.2-3

Clinton FPIE LERF Results by Accident Class

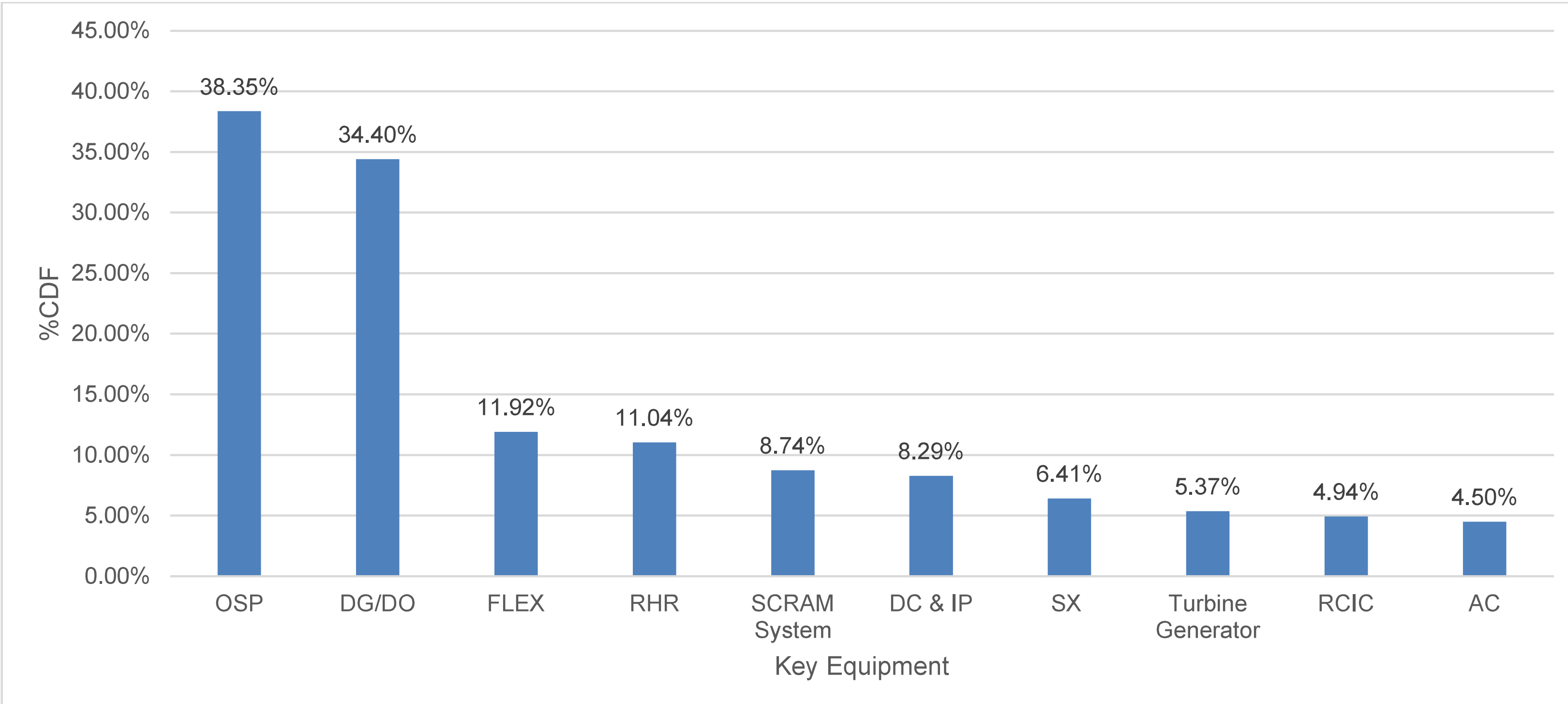

Figure 2.3.3-1

Clinton FPIE CDF Results by Key Equipment

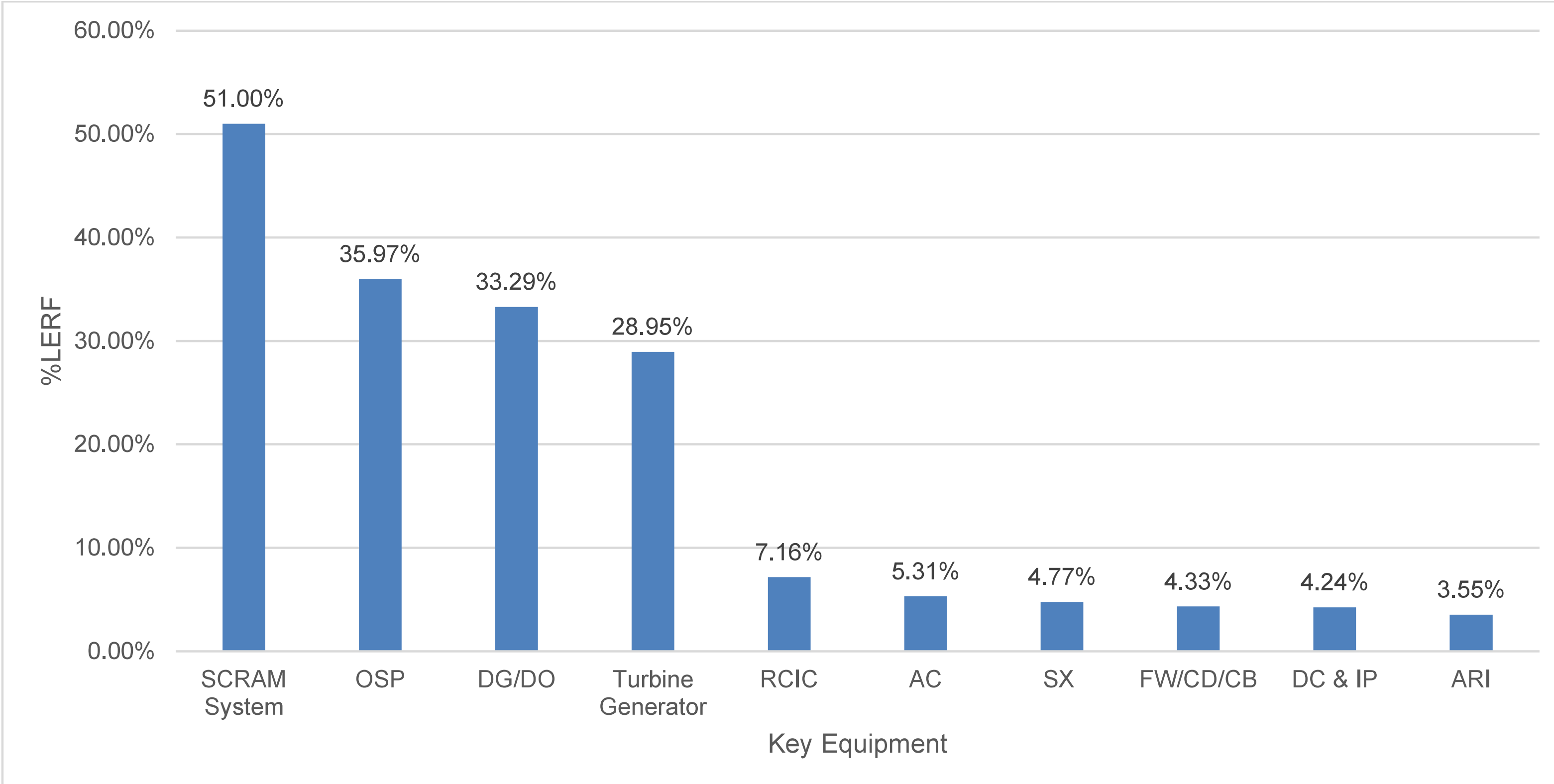

Figure 2.3.3-2

Clinton FPIE LERF Results by Key Equipment

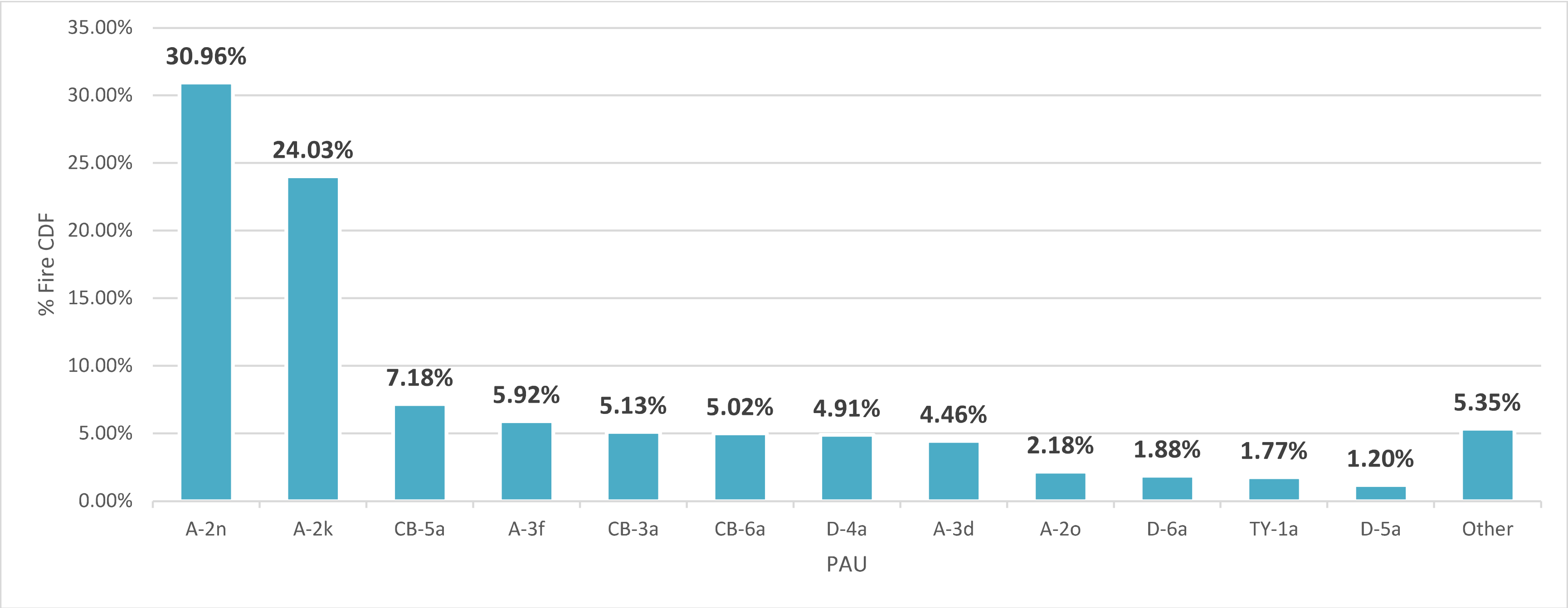

Figure 2.4.1-1

Clinton Fire CDF Results by PAU

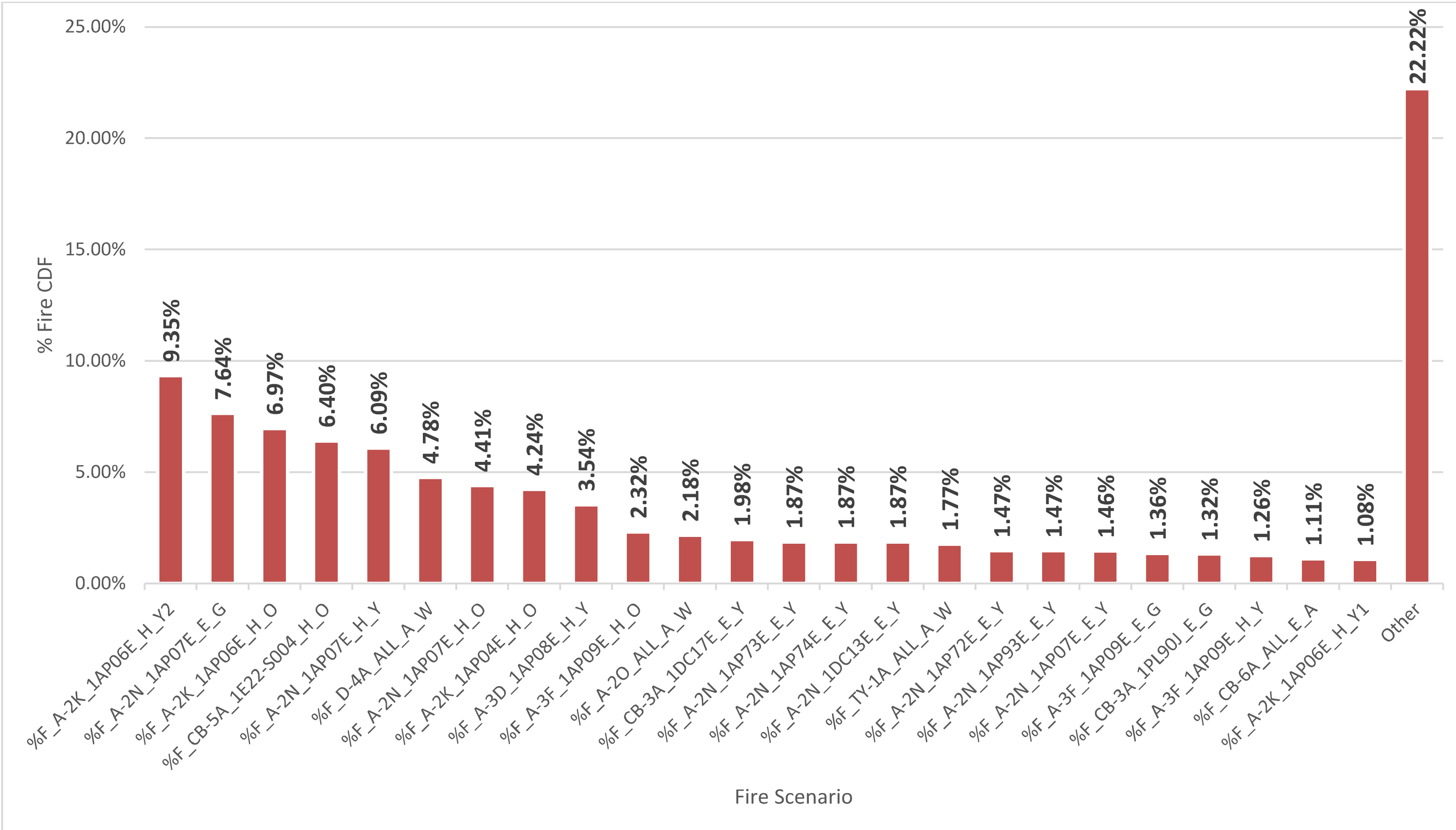

Figure 2.4.1-2

Clinton Fire CDF Results by Fire Scenario

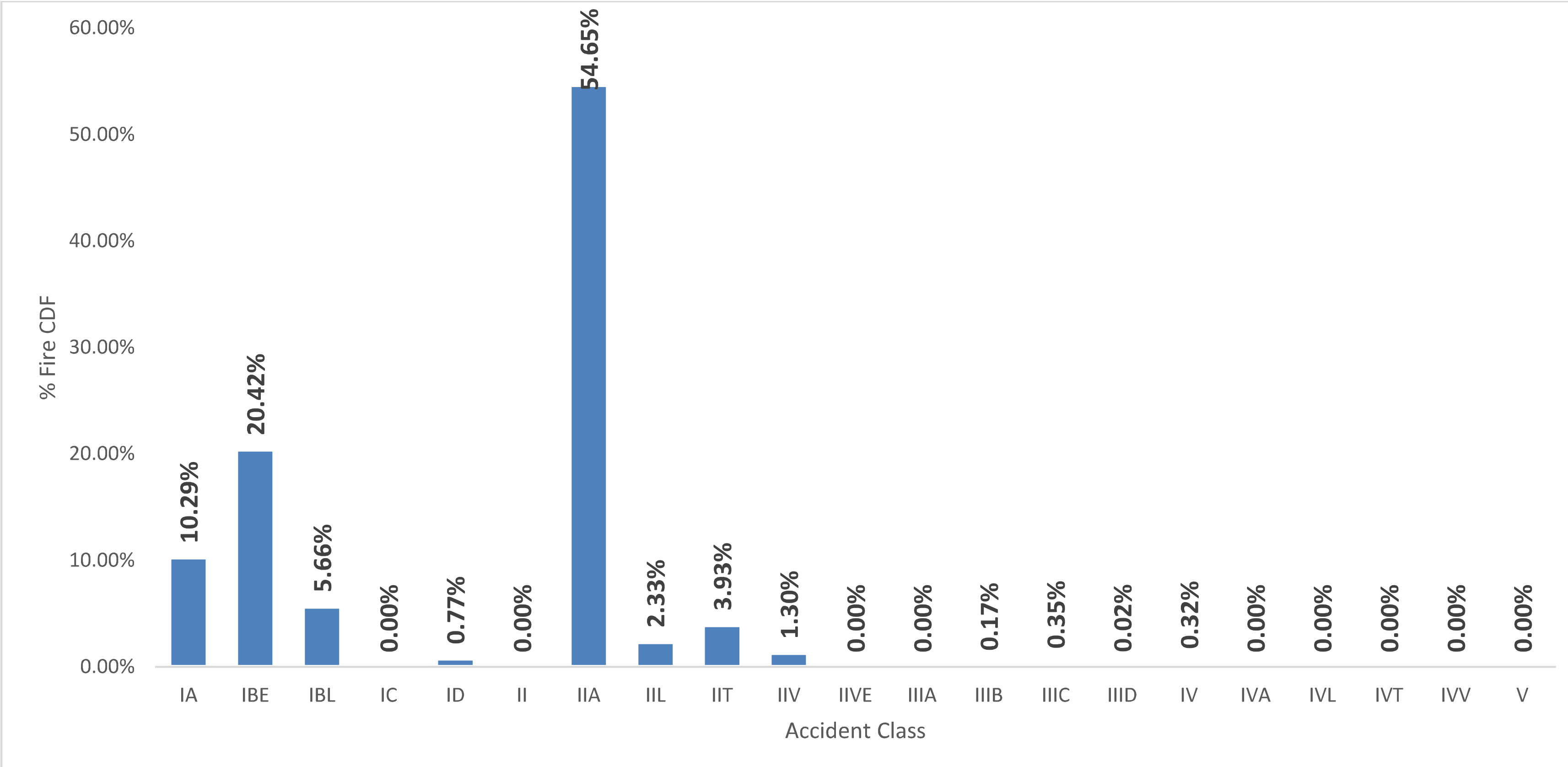

Figure 2.4.1-3

Clinton Fire CDF Results by Accident Class

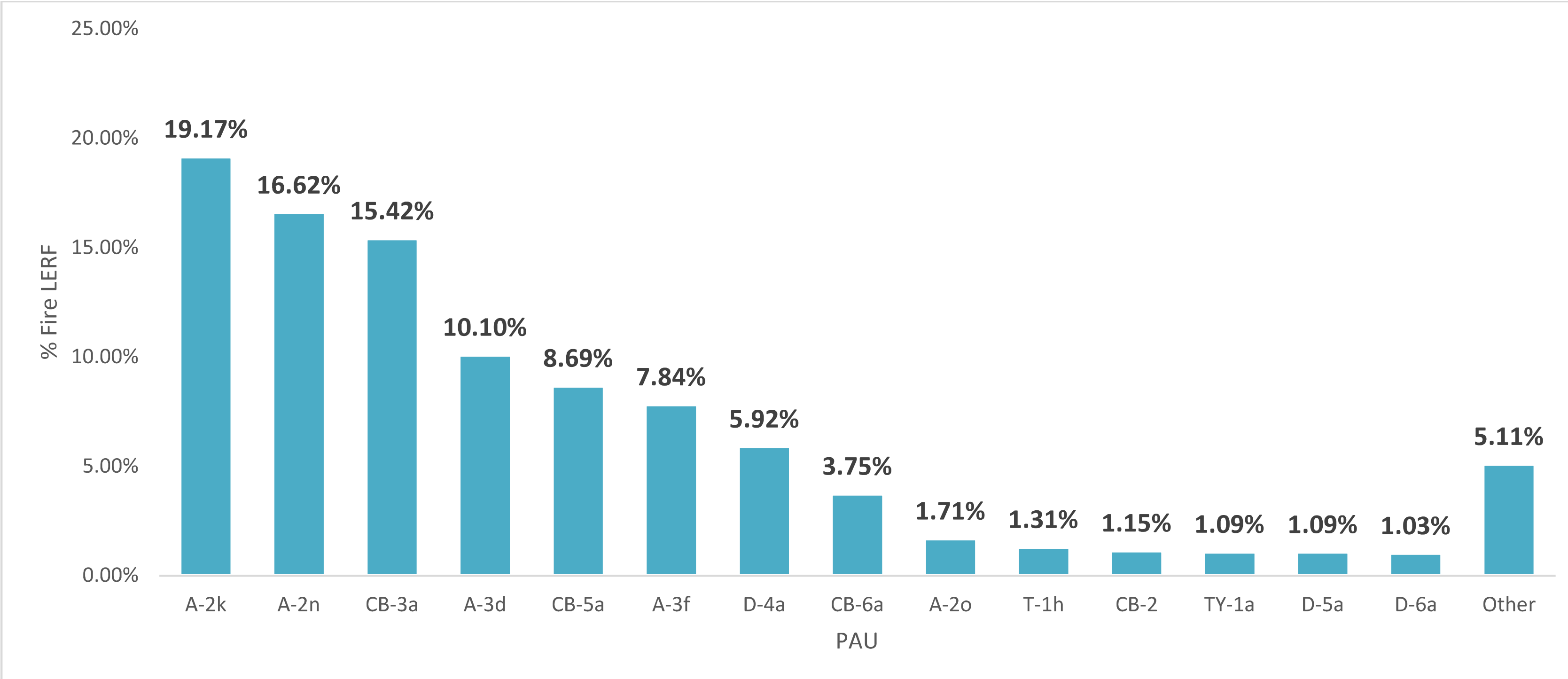

Figure 2.4.2-1

Clinton Fire LERF Results by PAU

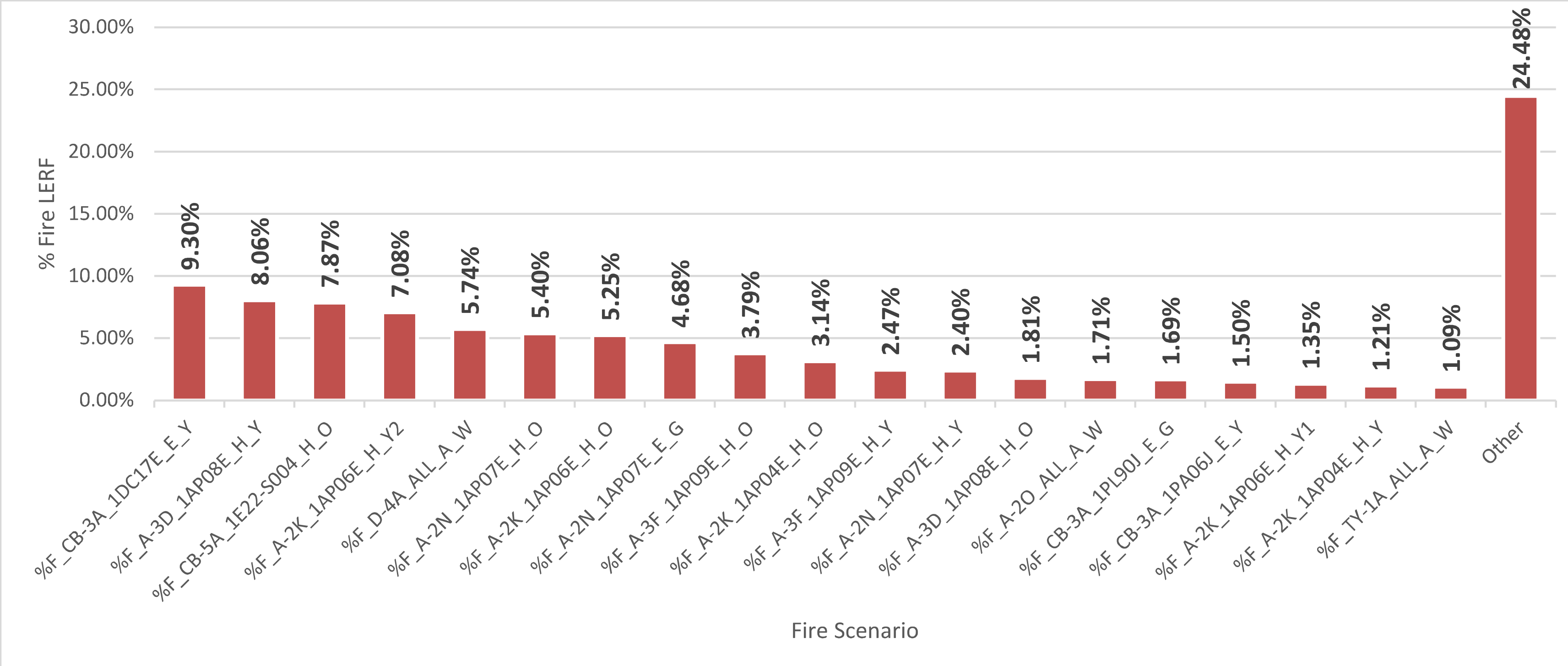

Figure 2.4.2-2

Clinton Fire LERF Results by Fire Scenario

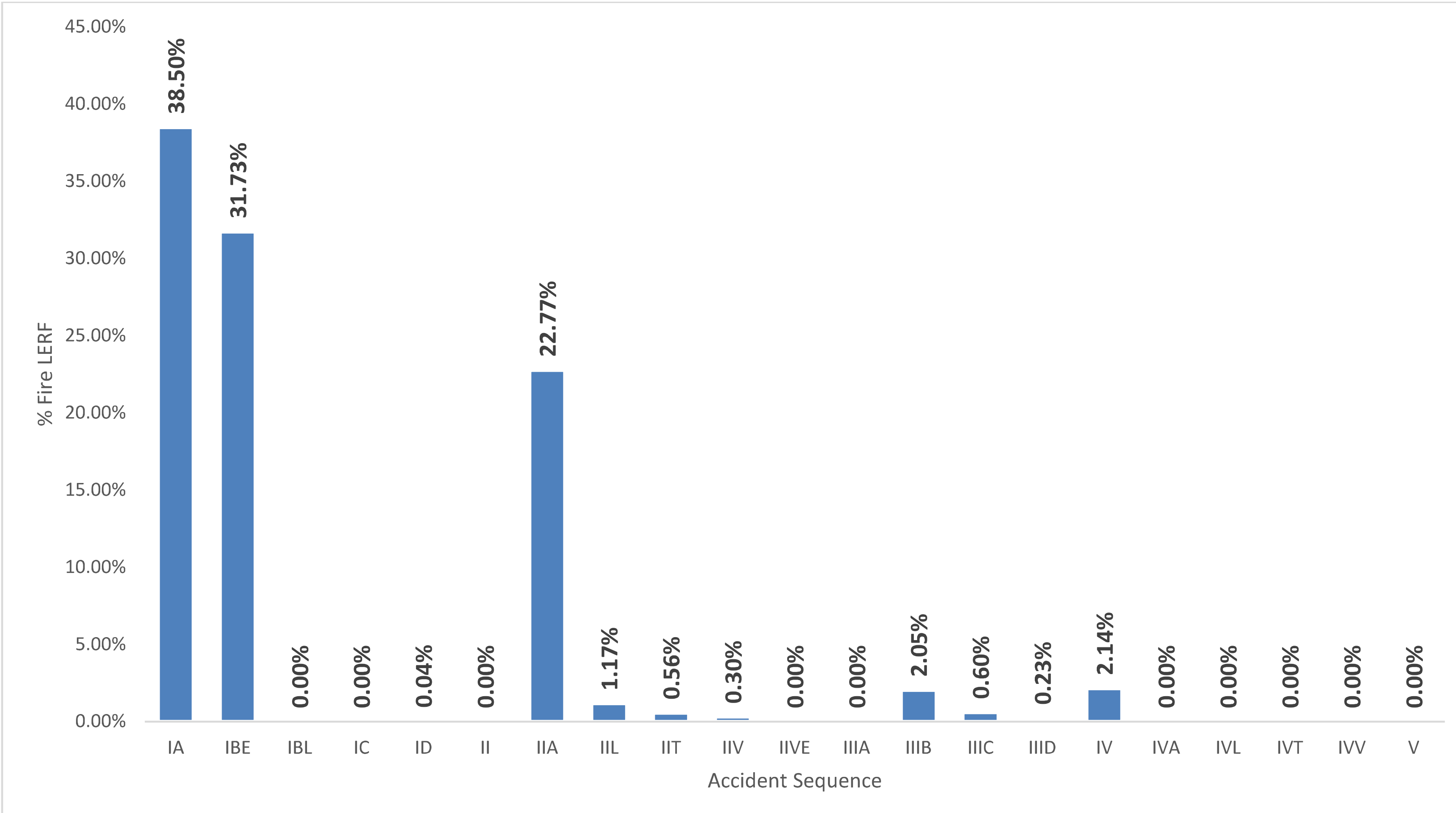

Figure 2.4.2-3

Clinton Fire LERF Results by Accident Class