NUREG-1815, Vol. 1

Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site

Final Report

Main Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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Division of New Reactor Licensing
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Abstract

This environmental impact statement (EIS) has been prepared in response to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by Exelon Generation Company, LLC (Exelon) for an early site permit (ESP). The proposed action requested in Exelon's application is for the NRC to (1) approve a site within the existing Clinton Power Station (CPS) boundaries as suitable for the construction and operation of a new nuclear power generating facility and (2) issue an ESP for the proposed site identified as the Exelon ESP site located adjacent to the CPS. In its application, Exelon proposes a plan for redressing the environmental effects of certain site-preparation and construction activities, i.e., those activities allowed by Title 10 of the Code of Federal Regulations (CFR) 50.10(e)(1), performed by an ESP holder under 10 CFR 52.25. In accordance with the plan, the site would be redressed if the NRC issues the requested ESP (containing the site redress plan), the ESP holder performs these site-preparation and construction activities, the ESP is not referenced in an application for a construction permit or combined operating license, and no alternative use is found for the site. This EIS includes the NRC staff's analysis that considers and weighs the environmental impacts of constructing and operating a new nuclear unit at the Exelon ESP site or at alternative sites, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation to the Commission regarding the proposed action.

The staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued. The staff's evaluation of the site safety and emergency preparedness aspects of the proposed action have been addressed in the staff's final safety evaluation report dated February 17, 2006.

This recommendation is based on (1) the application, including the Environmental Report (ER), submitted by Exelon; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process and on the draft EIS; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and this EIS. In addition, in making its recommendation, the staff determined that there are no environmentally preferable or obviously superior sites. Finally, the staff has concluded that the site-preparation and construction activities allowed by 10 CFR 50.10(e)(1) requested by Exelon in its application would not result in any significant adverse environmental impact that cannot be redressed.

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Executive Summary

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Exelon Generation Company, LLC (Exelon) for an early site permit (ESP) for a location identified as the Exelon ESP site, adjacent to the Clinton Power Station (CPS), Unit 1. The Exelon ESP site is located in DeWitt County, Illinois, approximately 10 km (6 mi) east of the City of Clinton. An ESP is a Commission approval of a location for siting one or more nuclear power facilities and is a separate action from the filing of an application for a construction permit (CP) or combined CP and operating license (combined license or COL) for such a facility. An ESP application may refer to a reactor's or reactors' characteristics or plant parameter envelope (PPE), which is a set of postulated design parameters that bound the characteristics of a reactor or reactors that might be built at a selected site; alternatively, an ESP application may refer to a detailed reactor design. The ESP is not a license to build a nuclear power plant; rather, the application for an ESP initiates a process undertaken to assess whether a proposed site is suitable should Exelon decide to pursue a CP or COL.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.) directs that an environmental impact statement (EIS) be prepared for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in Part 51 of Title 10 of the Code of Federal Regulations (CFR). The NRC regulations related to ESPs are delineated in Subpart A of 10 CFR Part 52. As set forth in 10 CFR 52.18, the Commission has determined that an EIS will be prepared during the review of an application for an ESP. The purpose of Exelon's requested action, issuance of the ESP, is for the NRC to determine whether the Exelon ESP site is suitable for a new nuclear unit by resolving certain safety and environmental issues before Exelon incurs the substantial additional time and expense of designing and seeking approval to construct such a facility at the site. Part 52 of Title 10 describes the ESP as a "partial construction permit." An applicant for a CP or COL for a nuclear power plant or plants to be located at the site for which an ESP was issued can reference the ESP, thus reducing the review of siting issues at that stage of the licensing process. However, a CP or COL to construct and operate a nuclear power plant is a major Federal action and will require an EIS be issued in accordance with 10 CFR Part 51.

Three primary issues – site safety, environmental impacts, and emergency planning – must be addressed in the ESP application. Likewise, in its review of the application, the NRC assesses Exelon's proposal in relation to these issues and determines if the application meets the requirements of the Atomic Energy Act and the NRC regulations. This EIS addresses the potential environmental impacts resulting from the construction and operation of a new nuclear unit at the Exelon ESP site.

In its application, Exelon requested authorization to perform certain site-preparation activities after the ESP is issued. The application, therefore, includes a site redress plan that specifies how Exelon would stabilize and restore the site to its pre-construction condition (or conditions consistent with an alternative use) in the event a nuclear power plant is not constructed on the approved site. Pursuant to 10 CFR 52.17(a)(2), Exelon did not address the benefits of the proposed action (e.g., the need for power). In accordance with 10 CFR 52.18, the EIS is focused on the environmental effects of construction and operation of a reactor, or reactors, that have characteristics that fall within the postulated site parameters.

Upon acceptance of the Exelon ESP application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing in the *Federal Register* a Notice of Intent (68 FR 66130) to prepare an EIS and conduct scoping. The staff held a public scoping meeting in Clinton, Illinois, on December 18, 2003, and visited the Exelon ESP site in March 2004. Subsequent to the scoping meeting and the site visit and in accordance with NEPA and 10 CFR Part 51, the staff determined and evaluated the potential environmental impacts of constructing and operating a new nuclear unit at the Exelon ESP site. Included in this EIS are (1) the results of the NRC staff's analyses, which consider and weigh the environmental effects of the proposed action (issuance of the ESP) and of constructing and operating a new nuclear unit at the ESP site, (2) mitigation measures for reducing or avoiding adverse effects, (3) the environmental impacts of alternatives to the proposed action, and (4) the staff's recommendation regarding the proposed action.

During the course of preparing this EIS, the staff reviewed the application (through revision 4), including the Environmental Report (ER) submitted by Exelon, consulted with Federal, State, Tribal, and local agencies, and followed the guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits*, to conduct an independent review of the issues. The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis for Nuclear Power Plants*, and NUREG-1555, *Environmental Standard Review Plan (ESRP)*. In addition, the staff considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this EIS.

Following the practice the staff used in of NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, and in the supplemental license renewal EISs, environmental issues are evaluated using the three-level standard of significance – SMALL, MODERATE, or LARGE – developed by NRC using guidelines from the Council on Environmental Quality. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

> 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.

Mitigation measures were considered for each environmental issue and are discussed in the appropriate sections.

The results of this evaluation were documented in a draft EIS issued for public comment in February 2005. During the comment period, the staff conducted a public meeting on April 19, 2005, near the Exelon ESP site to describe the results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft EIS. After the comment period closed, the staff considered and dispositioned all the comments received. These comments are addressed in Appendix E of this EIS.

The staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued. The staff's evaluation of the site safety and emergency preparedness aspects of the proposed action have been addressed in the staff's final safety evaluation report, published May 1, 2006.

This recommendation is based on (1) the application, including the ER submitted by Exelon; (2) consultation with other Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of public comments related to the environmental review that were received during the review process; and (5) the assessments summarized in the EIS, including the potential mitigation measures identified in the ER and this EIS. In addition, in making its recommendation to the Commission, the staff has determined that there are no environmentally preferable or obviously superior sites. Finally, the staff has concluded that the site-preparation and construction activities allowed by 10 CFR 50.10(e)(1) would not result in any significant adverse environmental impact that cannot be redressed.

Abbreviations/Acronyms

ABWR	Advanced Boiling Water Reactor
ac	acre(s)
ACE	U.S. Army Corps of Engineers
ACR-700	Advanced Canada Deuterium Uranium Reactor
ADAMS	Agencywide Document Access and Management System
AEC	U.S. Atomic Energy Commission
ALARA	as low as is reasonably achievable
AmerGen	AmerGen Energy Company, LLC
ANSI	American National Standards Institute
AP1000	Advanced Pressurized Water Reactor
APE	area of potential effect
AQCR	Air Quality Control Region
AQI	Air Quality Index
ATWS	anticipated transient without scram
BEA	Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation
BLS	U.S. Bureau of Labor Statistics
BOW	Bureau of Economic Analysis
Bq	becquerel
Btu	British thermal unit(s)
BWR	boiling water reactor
°C	Celsius
CANDU	Canada Deuterium Uranium
CARB	
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	curie(s)
cm	centimeter(s)
CNWRA	Center for Nuclear Waste Regulatory Analysis
CO	carbon monoxide
COL	combined license
CP	construction permit
CPS	Clinton Power Station
CWA	Clean Water Act of 1977 (also known as the Federal Water Pollution Control Act)
DBA	design basis accident
DEIS	draft environmental impact statement
DHS	Department of Homeland Security
DO	dissolved oxygen

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DU	depleted uranium
EAB	exclusion area boundary
ECL	effluent concentration limits
EGC	Exelon Generation Company
EIA	Energy Information Administration
EIS	environmental impact statement
EFL	extremely low frequency
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
ESBWR	Economic Simplified Boiling Water Reactor
ESRP	Environmental Standard Review Plan
ER	Environmental Report
ERA	Environmental Resource Associates
ESP	early site permit
Exelon	Exelon Generation Company, LLC
°F	Fahrenheit
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FR	Federal Register
fps	feet per second
ft	foot/feet
FWPCA	Federal Water Pollution Control Act (also known as the Clean Water Act of 1977)
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
gal	gallon(s)
GEIS	generic environmental impact statement
GEn&SIS	Geographical, Environmental and Siting Information
GIS	geographic information system
gpm	gallons per minute
GT-MHR	Gas Turbine-Modular Helium Reactor
ha	hectare(s)
hr	hour(s)
HRCQ	highway route controlled quantity

I	interstate
IAC	Illinois Administration Code
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
IDNR	Illinois Department of Natural Resources
IDOCEO	Illinois Department of Commerce and Economic Opportunity
IDOR	Illinois Department of Revenue
IDOT	Illinois Department of Transportation
IEEE	Institute of Electrical and Electronics
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois State Historic Preservation Agency
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
INHS	Illinois Natural History Survey
IOC	Illinois Office of the Controller
IPC	Illinois Power Company
IRIS	International Reactor Innovative and Secure
ISA	Illinois Stewardship Alliance
ISGS	Illinois State Geological Survey
ISU	Illinois State University
J	Joules
kg	kilogram(s)
km	kilometers)
kV	kilovolt(s)
kWh	kilowatt hour(s)
L	liter(s)
lb	pound(s)
L/d	liters per day
LLRWPAA	Low-Level Radioactive Waste Policy Amendments
LOCA	loss-of-coolant accident
LOS	level-of-service
LPZ	low population zone
LR	License Renewal
LWR	light water reactor
m	meter(s)
m^3	cubic meter(s)
m/s	meter(s) per second
m^3/d	cubic meter(s) per day

m^3/s	cubic meter(s) per second
m^3/yr	cubic meter(s) per year
MEI	maximally exposed individual
mgd	million gallons per day
mg/L	milligrams per liter
mGy	milligray(s)
mi	mile(s)
mL	milliliter(s)
mph	miles per hour
mrad	millirad(s)
mrem	millirem(s)
MSA	Metropolitan Statistical Area
MSDS	Material Safety Data Sheet
MSL	mean sea level
mSv	millisievert(s)
MT	metric ton(s) (or tonne[s])
MTU	metric ton(s) uranium
MW	megawatt(s)
MWd/MTU	megawatt days per metric ton of uranium
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
ng/J	nanogram per Joule
NAGPRA	Native Graves Protection and Repatriation Act
NAS	National Academy of Science
NCI	National Cancer Institute
NCDC	National Climate Data Center
NCRP	National Council on Radiation Protection and Measurements
NEIS	Nuclear Energy Information Service
NEPA	National Environmental Policy Act of 1969
NGO	non-governmental organization
NHPA	National Historic Preservation Act of 1966
NIEHS	National Institute of Environmental Health Sciences
NIST	National Institute of Standards
N	north
NE	northeast
NNE	north northeast
NOx	nitrogen oxide(s)
NOI	notice of intent
NOT	notice of termination
NPDES	National Pollutant Discharge Elimination System

NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulation
NWFR	Mississippi River National Wildlife and Fish Refuge
ODCM	Offsite Dose Calculation Manual
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PARs	Publicly Available Records
PBMR	Pebble Bed Modular Reactor
PGDP	Portsmouth Gaseous Diffusion Plant
pH	potential of hydrogen
PM	particulate matter
PM_{10}	particulate matter with a diameter of fewer than 10 micrometers
PNNL	Pacific Northwest National Laboratory
PPE	plant parameter envelope
PPWMP	Pollution Prevention and Waste Minimization Program
PV	photovoltaic
PVC	polyvinyl chloride
PWR	pressurized water reactor
FRCIC	reactor core isolation cooling
RCRA	Resource Conservation and Recovery Act of 1976
REMP	radiological environmental monitoring program
REPS	Renewable Energy Portfolio Standard
RI	radio interference
rms	root mean square
ROI	region of interest
RPHP	Radiation and Public Health Project
RSICC	Radiation Safety Information Computational Center
RTO	Regional Transmission Operator
Ryr-1	per reactor year
s	second(s)
scf	standard cubic feet
SE	southeast
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SFP	spent fuel pool
SHPO	State Historic Preservation Officer
SNF	spent nuclear fuel
SOx	sulfur oxide(s)

SPCC	Spill Prevention Control and Countermeasure
Sr-90	strontium-90
SR	State Route
SRS	Savannah River Site
SSAR	site safety analysis report
SW	southwest
SWPPP	stormwater pollution prevention plans
SWR	Service Water Reservoir
SWU	separative work units
TEDE	total effective dose equivalent
TIF	tax increment financing (districts)
TLD	thermoluminescent dosimeter
TSP	total suspended particulates
TVI	television interference
U_3O_8	yellowcake
UF_6	uranium hexafluoride
UFSAR	Updated Final Safety Analysis Report
UHS	ultimate heat sink
UO_2	uranium oxide
U.S.	United States
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WCR	Waste Confidence Rule
yr	year(s)
Y-9	yttrium

1.0 Introduction

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Exelon Generation Company, LLC (Exelon) for an early site permit (ESP) for a location identified as the Exelon ESP site adjacent to the Clinton Power Station (CPS), Unit 1, in Clinton, Illinois. This application has been revised, through Revision 4, which was submitted to the NRC by Exelon on April 14, 2006. Under the NRC regulations in Title 10 of the Code of Federal Regulations (CFR) Part 52, and in accordance with the applicable provisions of 10 CFR Part 51, which are the NRC regulations implementing the National Environmental Policy Act of 1969 (NEPA), the NRC is required to prepare an environmental impact statement (EIS) as part of its review of an ESP application. As required by 10 CFR 51.26, the NRC has published in the *Federal Register* a Notice of Intent (68 FR 66130) to prepare an EIS, conduct scoping, and publish a draft EIS for public comment. The staff considered the public comments in developing the final EIS. A separate safety evaluation report (SER) has been prepared in accordance with 10 CFR Part 52.

1.1 Background

An ESP is a Commission approval of a site or sites for one or more nuclear power facilities. The filing of an application for an ESP is a process that is separate from the filing of an application for a construction permit (CP) or combined construction and operating license (combined license or COL) for such a facility. The ESP application and review process makes it possible to evaluate and resolve safety and environmental issues related to siting before the applicant makes large commitments of resources. If the ESP is approved, then the applicant can "bank" the site for up to 20 years for future reactor siting. In addition, if the ESP includes a site redress plan, the ESP holder could conduct specific site-preparation activities pursuant to 10 CFR 50.10(e)(1). An ESP does not authorize construction and operation of a nuclear power plant. To construct and operate a nuclear power plant, an ESP holder must obtain a CP and operating license or a COL, which is a separate major Federal action and will require that an EIS be issued in accordance with 10 CFR Part 51.

As part of its evaluation of the environmental impacts of the action proposed in an ESP application, the NRC prepares an EIS in accordance with 10 CFR 52.18. Because the site suitability encompasses construction and operational parameters, the EIS addresses impacts of both construction and operation of reactors and associated facilities. In a review separate from the EIS process, the NRC analyzes the safety characteristics of the proposed site and emergency planning information. These latter two analyses are documented in a SER that presents the conclusions reached by the NRC regarding whether there is reasonable assurance that a reactor or reactors having characteristics that fall within the parameters for the site can be constructed and operated without undue risk to the health and safety of the public, whether there are significant impediments to the development of emergency plans, and whether site characteristics are such that adequate security plans and measures can be developed. In addition, if the applicant proposes major features of emergency plans or complete and integrated emergency plans, the SER will document whether such major features are acceptable or whether the complete and integrated emergency plans provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency.

1.1.1 Plant Parameter Envelope

The applicant for an ESP need not provide a detailed design of a reactor or reactors and the associated facilities, but should provide sufficient bounding parameters and characteristics of the reactor or reactors and associated facilities so that an assessment of site suitability can be made. Consequently, the ESP application may refer to a plant parameter envelope (PPE) as a surrogate for a nuclear power plant and its associated facilities.

A PPE is a set of values of plant design parameters that an ESP applicant expects will bound the design characteristics of the reactor or reactors that might be constructed at a given site. The PPE values are a surrogate for actual reactor design information. Analysis of environmental impacts based on a PPE approach permits an ESP applicant to defer the selection of a reactor design until the CP or COL stage. The PPE reflects upper or lower bounds (as appropriate) of the values for each parameter it encompasses rather than the characteristics of any specific reactor design. The PPE is discussed in more detail in Section 3.2 of this EIS.

1.1.2 Site-Preparation and Preliminary Construction Activities

The holder of an ESP, or an applicant for a CP (10 CFR Part 50) or a COL (Subpart C of 10 CFR Part 52) that references an ESP with an approved site redress plan, may in accordance with 10 CFR 52.25(a), perform the site-preparation activities and preliminary construction activities allowed by 10 CFR 50.10(e)(1), provided that the final ESP EIS concludes that the activities will not result in any significant adverse environmental impacts that cannot be redressed. Exelon provided a site redress plan as part of its ESP application (Exelon 2006) to obtain authorization to conduct certain site-preparation and preliminary construction activities. Activities permitted under an ESP include preparation of the site for construction of the facility, installation of temporary construction support facilities, excavation for facility structures, construction of service facilities, and construction of certain structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents (10 CFR 50.10(e)(1)). This is discussed in more detail in Section 4.11 of this EIS.

1.1.3 ESP Application and Review

In accordance with 10 CFR 52.17(a)(2), Exelon submitted an Environmental Report (ER) as part of its ESP application (Exelon 2006). The ER focuses on the environmental effects of construction and operation of reactors with characteristics that fall within the PPE. The ER also includes an evaluation of alternative sites to determine whether there is an obviously superior alternative to the proposed site. An ESP ER is not required to include an assessment of energy alternatives or the benefits of the proposed action, e.g., the need for power. Exelon did not include a discussion on need for power; however, there is a discussion of energy alternatives that is evaluated in Chapter 8 of this EIS.

The NRC standards for review of the ESP application are outlined in 10 CFR 52.18. Like the ER, this EIS focuses on the environmental effects of construction and operation of reactors that have characteristics that fall within the PPE developed by Exelon, and includes an evaluation of alternative sites to determine whether there is any obviously superior alternative to the proposed Exelon ESP site. The EIS does not include an assessment of the benefits of the proposed action.

The NRC staff conducts its reviews of ESP applications in accordance with guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits* (NRC 2004). The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis for Nuclear Power Plants* (NRC 1987), and NUREG-1555, *Environmental Standard Review Plan (ESRP)* (NRC 2000). RS-002 provides guidance to NRC staff reviewers to help ensure a thorough, consistent, and disciplined review of any ESP application. As stated in RS-002, an applicant may elect to use a PPE approach instead of supplying specific design information. The staff's June 23, 2003, responses to comments received on draft RS-002 (ML031710698) provide additional insights on the staff's expectations and potential approach to the review of an application employing the PPE approach (NRC 2003). Specifically, the NRC staff tasked to perform the environmental review has been trained in using the guidance in the ESRP and RS-002, and in incorporating the PPE concept into their review. The reviewers adapted the ESRP review guidance to account for the PPE concept and the findings of this EIS reflect that approach.

In addition, the staff also considered the information and analyses provided in the *Generic Environmental Impact Statement for License Renewal (GEIS)* (NRC 1996)[a] in its review. Because the GEIS included a review of data from all operating nuclear power plants, some of the information was useful for the environmental review of the proposed action. The staff has identified in the text those areas where this information has been used.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and Addendum 1.

Pursuant to 10 CFR 52.18, an EIS prepared by the NRC staff on an application for an ESP focuses on the environmental effects of construction and operation of a reactor, or reactors, that have characteristics that fall within the postulated site parameters. Such an EIS must also include an evaluation of alternative sites to determine whether there is any obviously superior alternative site to the site proposed. The Commission's regulations recognize that certain matters need not be resolved at the ESP stage (i.e., an assessment of the benefits, need for power) and, thus, may be deferred until an applicant decides to apply for a CP or COL. Further, the NRC staff realizes that certain information pertaining to the environmental impacts of construction and operation of new nuclear power facilities may not be available during the NRC staff review of the ESP application.

In its application and in responses to requests for additional information (RAIs), Exelon did not or was unable to provide sufficient information and analysis for certain issues to allow the NRC staff to complete their independent analysis of these issues without making speculative assumptions. The staff was unable to determine a single significance level for such issues in Chapters 4, 5, and 6 of this EIS, and therefore, these issues are unresolved for the Exelon ESP site. In their analysis of other issues, the staff relied on reasonable assumptions made by Exelon or the staff. These assumptions are identified in each section and are documented in Appendixes J and K in this EIS. The NRC staff intends to confirm these assumptions at the CP or COL stage to determine whether there is new and significant information from that discussed herein.

As provided by 10 CFR 52.39(a)(2), the Commission shall treat those matters that are resolved through this EIS as resolved in any later proceeding on an application for a CP or COL referencing the requested Exelon ESP unless new and significant information pertaining to these issues is identified. This complements the obligation of a COL applicant referencing an ESP to provide information to resolve any significant environmental issue not considered in the previous proceeding on the ESP. Inasmuch as an ESP and a COL are major Federal actions, both actions require the preparation of an EIS pursuant to 10 CFR 51.20. As provided in 10 CFR 52.79 and under NEPA, the CP or COL environmental review will be informed by the EIS prepared at the ESP stage, and the NRC staff intends to use tiering and incorporation-by-reference whenever it is appropriate to do so. The CP or COL applicant must address any other issue not considered and unresolved in the EIS for the ESP. Moreover, pursuant to 10 CFR 51.70(b), the NRC is required to independently evaluate and be responsible for the reliability of all information used in an EIS prepared for a CP or COL application, and the staff may (1) inquire into the continued validity of information disclosed in an EIS for an ESP that is referenced in a COL application, and (2) look for any new information that may affect the assumptions, analyses, or conclusions reached in the ESP EIS.

In addition, measures and controls to limit any adverse impact will be identified and evaluated for feasibility and adequacy in limiting adverse impacts at the ESP stage, where possible, and at the CP or COL stage. As a result of the staff's environmental review of the ESP application, the staff may determine that conditions or limitations on the ESP may be necessary in specific areas, as set forth in 10 CFR 52.24. Therefore, the staff has identified in this EIS when and how assumptions and bounding values limit its conclusions on the environmental impacts to a particular resource.

Following requirements set forth in 10 CFR Part 51 and the guidance in RS-002, on November 25, 2003, the NRC published a notice of intent in the *Federal Register* to prepare an EIS and conduct scoping (68 FR 66130). The NRC environmental staff (and its technical experts from the Pacific Northwest National Laboratory retained to assist the staff) held a scoping meeting on December 18, 2003, to obtain public input on the scope of the environmental review and visited the Exelon ESP site and the alternative sites (Dresden, Quad Cities, Braidwood, Byron, LaSalle, and Zion) in March 2004 to gather information and to become familiar with the sites and their environs. During these site visits, the staff and its contractors met with Exelon staff, public officials, and the public. The staff reviewed the comments received during scoping and contacted Federal, State, Tribal, regional, and local agencies to solicit comments. A list of the organizations contacted is provided in Appendix B. Other documents related to the Exelon ESP site were reviewed and are listed as references where appropriate.

The results of the NRC staff's analysis were documented in a draft EIS (DEIS) issued for public comment on March 2, 2005. A 75-day comment period began on March 11, 2005, when the U.S. Environmental Protection Agency issued a Notice of Availability (70 FR 12211) of the draft EIS to allow members of the public to comment on the results of the NRC staff's review. A public meeting was held April 19, 2005, near the site during the public comment period. During this public meeting, the staff described the results of the NRC environmental review, answered questions related to the review, and provided members of the public with information to assist them in formulating their comments. Comments on the draft EIS and the staff's response are provided in Appendix E. This final EIS has change bars in the margin to denote where changes have been made since the DEIS was published.

On August 6, 2004, the Atomic Safety and Licensing Board admitted a contention of Intervenors (Environmental Law and Policy Center, Nuclear Energy Information Service, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, and Public Citizen) referred to as the Clean Energy Alternatives Contention. Following the issuance of the DEIS, Exelon moved for summary disposition of the contention on March 17, 2005. Shortly thereafter, the Intervenors sought to amend their contention. On July 28, 2005, the Board denied the motion to amend the environmental contention and granted summary disposition of the contention; the Board also terminated the contested portion of the proceeding. On August 12, 2005, the Intervenors filed a petition for Commission review of the Board's dismissal of the contention. On December 12, 2005, the Commission denied the petition for review (see

Exelon Generation Company, LLC [Early Site Permit for Clinton ESP Site], CLI-05-29, 62 NRC 801(205)). On February 8, 2006, the Intervenors petitioned the U.S. Court of Appeals for the Seventh Circuit for review of the Board and Commission decisions. The appeal is pending before the Court of Appeals.

To guide its assessment of environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts using Council on Environmental Quality guidance (40 CFR 1508.27). Using this approach, the NRC established three significance levels: SMALL, MODERATE, or LARGE. The definitions of the three significance levels are 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.
>
> 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.

This EIS presents the staff's analysis, which considers and weighs the environmental impacts of the proposed action at the Exelon ESP site, including the environmental impacts associated with construction and operation of reactors at the site, the impacts of construction and operation of reactors at alternative sites, the environmental impacts of alternatives to granting the ESP, and the mitigation measures available for reducing or avoiding adverse environmental effects. This EIS also provides the NRC staff's recommendation to the Commission regarding the suitability of the Exelon ESP site for the construction and operation of reactors that have characteristics that fall within the PPE.

1.2 The Proposed Federal Action

The proposed Federal action is issuance, under the provisions of 10 CFR Part 52, of an ESP for the Exelon site for one additional nuclear unit that has characteristics that fall within the Exelon PPE (see Appendix J). In addition, Exelon proposes a plan for redressing the environmental effects of certain site-preparation and preliminary construction activities, i.e., those activities allowed by 10 CFR 50.10(e)(1), performed by an ESP holder under 10 CFR 52.25. In accordance with the plan, the site would be redressed if the NRC issues the requested ESP (containing the site redress plan), the ESP holder performs these site-preparation and preliminary construction activities, the ESP is not referenced in an application for a CP or COL, and no alternative use is found for the site. While the applicant is not currently proposing construction and operation of a new nuclear unit, this EIS analyzes the environmental impacts that could result from the construction and operation of a new nuclear unit at the Exelon ESP site or at one of the six alternative sites. These impacts are analyzed to determine if the proposed ESP site is suitable for the addition of the new nuclear unit and whether there is an alternative site that is obviously superior to the proposed site.

The site proposed by Exelon is located in DeWitt County in central Illinois, near the City of Clinton. The site is approximately 35 km (22 mi) south of Bloomington, Illinois, and 35 km (22 mi) north of Decatur, Illinois. The site is completely within the confines of the current CPS site, with the new unit to be adjacent to the existing Unit 1.

No specific plant design has been chosen by Exelon for the new nuclear unit; instead, a set of bounding plant parameters known as a PPE has been specified to envelop the design to be considered for the ESP site. The PPE is based on the addition of power generation of one new nuclear unit composed of one to eight reactors or reactor modules, as described in Section 3.2. These multiple reactors or modules (the number of which may vary depending on the reactor type selected) would be grouped into one facility or unit. In this EIS, the proposed site is evaluated for construction and operation of various numbers of new reactors and/or modules, configured as one operating unit, up to a total of 6800 MW(t). The new unit would use either a wet cooling (natural draft or mechanical draft cooling towers) or a hybrid wet/dry cooling system.[a]

1.3 The Purpose and Need for the Proposed Action

The purpose and need for the proposed action (issuance of an ESP) is to provide stability in the licensing process by addressing safety and environmental issues before plants are built, rather than after construction is completed. This process allows for early resolution of many safety and environmental issues that may be identified for the ESP site. In the absence of an ESP, an applicant may apply for a CP and operating licenses under 10 CFR Part 50 when safety and environmental reviews of applications would continue during plant construction. Alternatively, all safety and environmental issues would have to be addressed at the time of the staff's review of a COL submitted under 10 CFR Part 52 if no ESP for the site were referenced. Although actual construction and operation of the facility would not take place until a COL is granted,

(a) Exelon also states that a third option, use of a dry cooling system, is being proposed. However, the applicant further states that full wet or hybrid wet/dry cooling processes have been assumed for most purposes because out of the options proposed, they have the greatest consumptive water uses. The applicant does not provide information on a dry cooling system to support an environmental analysis nor does the applicant address the adverse environmental impacts of such a system (noise, large footprint, and inefficiency). Therefore, the staff did not evaluate a dry cooling system. Should Exelon choose to use a dry cooling system at the ESP site in a CP or COL application, the staff will evaluate the environmental impacts of construction and operation of the system during that review.

certain lead-time activities, such as ordering and procuring certain components and materials necessary to construct the plant, may begin before the COL is granted. As a result, without the ESP review process, there could be a considerable expenditure of funds, commitment of resources, and passage of time before site safety and environmental issues are finally resolved.

1.4 Alternatives to the Proposed Action

Section 102(2)(C)(iii) of NEPA (42 USC 4321, et seq.) states that EISs will include a detailed statement on alternatives to the proposed action. The NRC regulations for implementing Section 102(2) of NEPA provide for inclusion of a chapter in an EIS discussing the environmental impacts of the proposed action and the alternatives (10 CFR Part 51, Subpart A, Appendix A). Chapter 8 of this EIS discusses the environmental impacts of four categories of alternatives: (1) the no-action alternative, (2) alternative energy sources, (3) system design alternatives, and (4) alternative sites. The Commission determined that evaluation of energy alternatives is not required for an ESP; however, Exelon included a discussion of energy alternatives in its ER, and, therefore, the staff conducted an evaluation of energy alternatives.

The six alternative sites that are considered are all Exelon sites located in Illinois: Braidwood, Byron, Dresden, Quad Cities, LaSalle, and Zion. The environmental analysis was performed using reconnaissance-level information. Chapter 8 also includes sections discussing (1) Exelon's region of interest for identification of alternative plant sites, (2) the methodology used by Exelon to select alternative sites and the proposed Exelon ESP site, and (3) generic issues consistent among alternative sites. Chapter 9 compares the environmental impacts at the Exelon ESP site to the alternative sites and to the no-action alternative and qualitatively determines whether an obviously superior alternative site to the proposed site exists.

1.5 Compliance and Consultations

Prior to construction and operation of a new reactor, Exelon is required to hold certain Federal, State, and local environmental permits, as well as meet applicable Federal and State statutory requirements. In its ER, Exelon provides a list of environmental approvals and consultations associated with the Exelon ESP. Because an ESP is limited to establishing the acceptability of the proposed site for future development, the authorizations Exelon will need from Federal, State, and local authorities for construction and operation are not yet required; therefore, they have not been obtained. However, Exelon will need to obtain the necessary authorizations to conduct the site-preparation activities specified in the site redress plan. Potential authorizations and consultations relevant to the proposed ESP are included in Appendix I. The information provided in Appendix I is based on guidance from NUREG-1555, *Environmental Standard Review Plan (ESRP)* (NRC 2000).

The staff reviewed the list and has contacted the appropriate Federal, State, and local agencies to identify any compliance, permit, or significant environmental issues of concern to the reviewing agencies that may impact the suitability of the Exelon ESP site for the construction and operation of the reactors that fall within the PPE.

1.6 Report Contents

The subsequent chapters of this EIS are organized as follows. Chapter 2 describes the proposed site and discusses the environment that would be affected by the addition of a new nuclear unit. Chapter 3 examines the power plant characteristics to be used as the basis for evaluation of the environmental impacts. The evaluations described in Chapter 3 are based on the PPE as well as site characteristics for which information is currently available. Chapters 4 and 5 examine site suitability by analyzing the environmental impacts of construction (Chapter 4) and operation (Chapter 5) of the proposed new nuclear unit. Chapter 6 analyzes the environmental impacts of the fuel cycle, transportation of radioactive materials, and decommissioning, while Chapter 7 discusses the cumulative impacts of the proposed action as defined in 40 CFR Part 1508. Chapter 8 explains how the alternative sites were selected and analyzes the alternative sites and systems. Chapter 9 compares the proposed action with the alternatives, and Chapter 10 summarizes the findings of the preceding chapters and presents the staff's recommendation with respect to (1) the Commission's approval of the proposed site for an ESP based on the staff's evaluation of environmental impacts and (2) the conclusions regarding the site redress plan.

The appendixes to the EIS provide the following additional information.

- Appendix A – Contributors to the EIS
- Appendix B – Organizations Contacted
- Appendix C – Chronology of NRC Staff Environmental Review Correspondence Related to Exelon Generation Company, LLC's Application for Early Site Permit at the Exelon ESP Site
- Appendix D – Scoping Meeting Comments and Responses
- Appendix E – Draft Environmental Impact Statement Comments and Responses
- Appendix F – Key Correspondence
- Appendix G – Data and Information to Support Transportation Discussion

- Appendix H – Supporting Documentation on Radiological Dose Assessment
- Appendix I – Required Authorizations and Consultations
- Appendix J – Plant Parameter Envelope Values
- Appendix K – Key Statements from the Exelon Environmental Report Considered in the NRC Staff's Environmental Analysis.

1.7 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy,* Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

68 FR 66130. "Exelon Generation Company, LLC, Clinton Early Site Permit; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." U.S. Nuclear Regulatory Commission, Washington, D.C. *Federal Register*. Docket No. 52-007. November 25, 2003.

70 FR 12211. "EIS No. 050096, Draft EIS, NRC, IL, Early Site Permit (ESP) at the Exelon ESP Site, Application for ESP on One Additional Nuclear Unit, within the Clinton Power Station (CPS)." Environmental Protection Agency, Washington, D.C. *Federal Register*. March 11, 2005.

Exelon Generation Company, LLC (Exelon). 2006. *Exelon Generation Company LLC, Early Site Permit Application: Environmental Report, Rev. 4*. Exelon Nuclear, Kennett Square, Pennsylvania.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

U.S. Nuclear Regulatory Commission (NRC). 1987. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*. NUREG-0800, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vols. 1 and 2, NRC, Washington, D.C. Available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan*. NUREG-1555, Vol. 1, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2003. Letter from J.L. Lyons, Office of Nuclear Reactor Regulation, NRC, to R.L. Simard, Nuclear Energy Institute, dated June 23, 2–3, "U.S. Nuclear Regulatory Commission Responses to Nuclear Energy Institute (NEI) Comments on Draft RS-002, Processing Applications for Early Site Permits (ML031710698).

U.S. Nuclear Regulatory Commission (NRC). 2004. *Processing Applications for Early Site Permits*. RS-002, NRC, Washington, D.C. (May 3, 2004).

2.0 Affected Environment

The site proposed by Exelon Generation Company, LLC (Exelon) for an early site permit (ESP) is located in DeWitt County, Illinois, within the existing boundaries of the current Clinton Power Station (CPS). The CPS property is owned by AmerGen Energy Company, LLC (AmerGen). The site is located on the shore of Clinton Lake approximately 10 km (6 mi) east of the City of Clinton. One generating unit (Unit 1) is currently located on the CPS site. The station location is described in Section 2.1, with the land, meteorology and air quality, geology, radiological environment, water, ecology, socioeconomics, historic and cultural resources, and environmental justice of the site presented in Sections 2.2 through 2.10, respectively. Section 2.11 examines related Federal projects, and references are presented in Section 2.12.

2.1 Site Location

Exelon's proposed ESP location is within the CPS site (see Figure 2-1). The ESP facility would be located 213 m (700 ft) south of the current CPS facility.

The ESP site is located in rural DeWitt County, which had a population of approximately 17,000 in 2000. Figure 2-2 shows the location of the CPS in relationship to the counties and principal cities and towns within an 80-km (50-mi) radius of the site. The site is located between Bloomington and Decatur, which are 35 km (22 mi) to the north and 35 km (22 mi) to the south, respectively. In addition, the site is located between the Cities of Lincoln and Champaign-Urbana, 45 km (28 mi) to the west and 48 km (30 mi) to the east, respectively. Illinois State Route (SR) 54 passes approximately 1.6 km (1 mi) north of the ESP site; Illinois SR 10 passes approximately 5 km (3 mi) south; and Illinois SR 48 is approximately 8 km (5 mi) east of the ESP site (see Figure 2-3). There is one active railroad line within the vicinity: the Canadian National Railroad runs parallel to Illinois SR 54 and traverses the vicinity approximately 1.6 km (1 mi) north of the site. There are three active private airports nearby: the Martin Airport is located approximately 6 km (4 mi) south of the site; the Thorp Airport is located approximately 8 km (5 mi) northwest of the site; and the Baker Strip is located approximately 8 km (5 mi) southeast of the site. The ESP site is situated on Clinton Lake, which was formed by the construction of an earthen dam across Salt Creek, 366 m (1200 ft) downstream from the confluence of Salt Creek with the North Fork of Salt Creek. The ESP site is approximately 5 km (3 mi) northeast of the dam, located on a peninsula between the two arms of the lake, at an approximate grade elevation of 224 m (736 ft). The normal lake pool elevation is 210 m (690 ft), with a surface area of 1981 ha (4895 ac). The station occupies approximately 187 ha (461 ac) of land. All site land, subsurface lands, and mineral rights are owned by AmerGen.

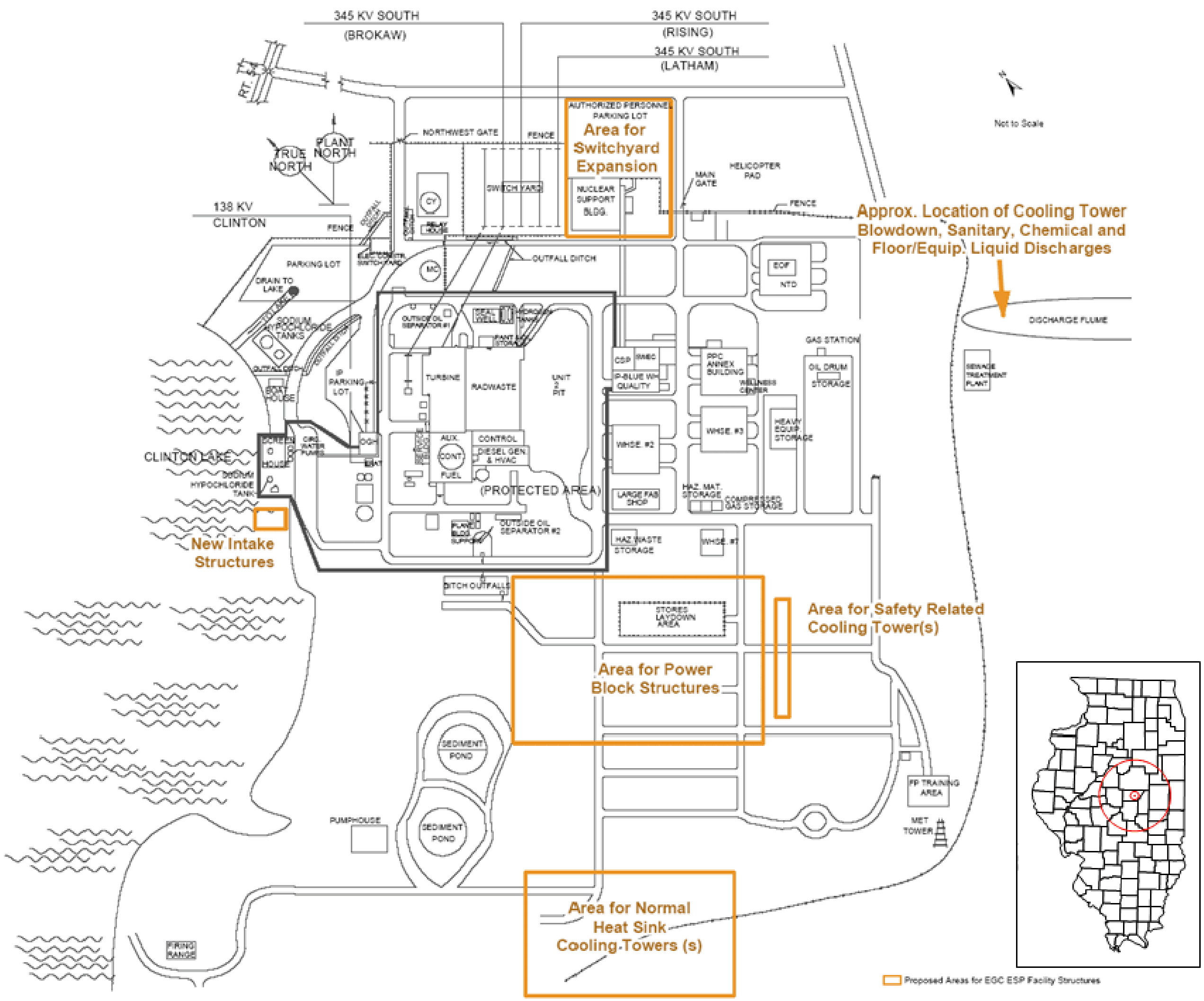

Figure 2-1. Location of ESP Structures Relative to CPS Facilities

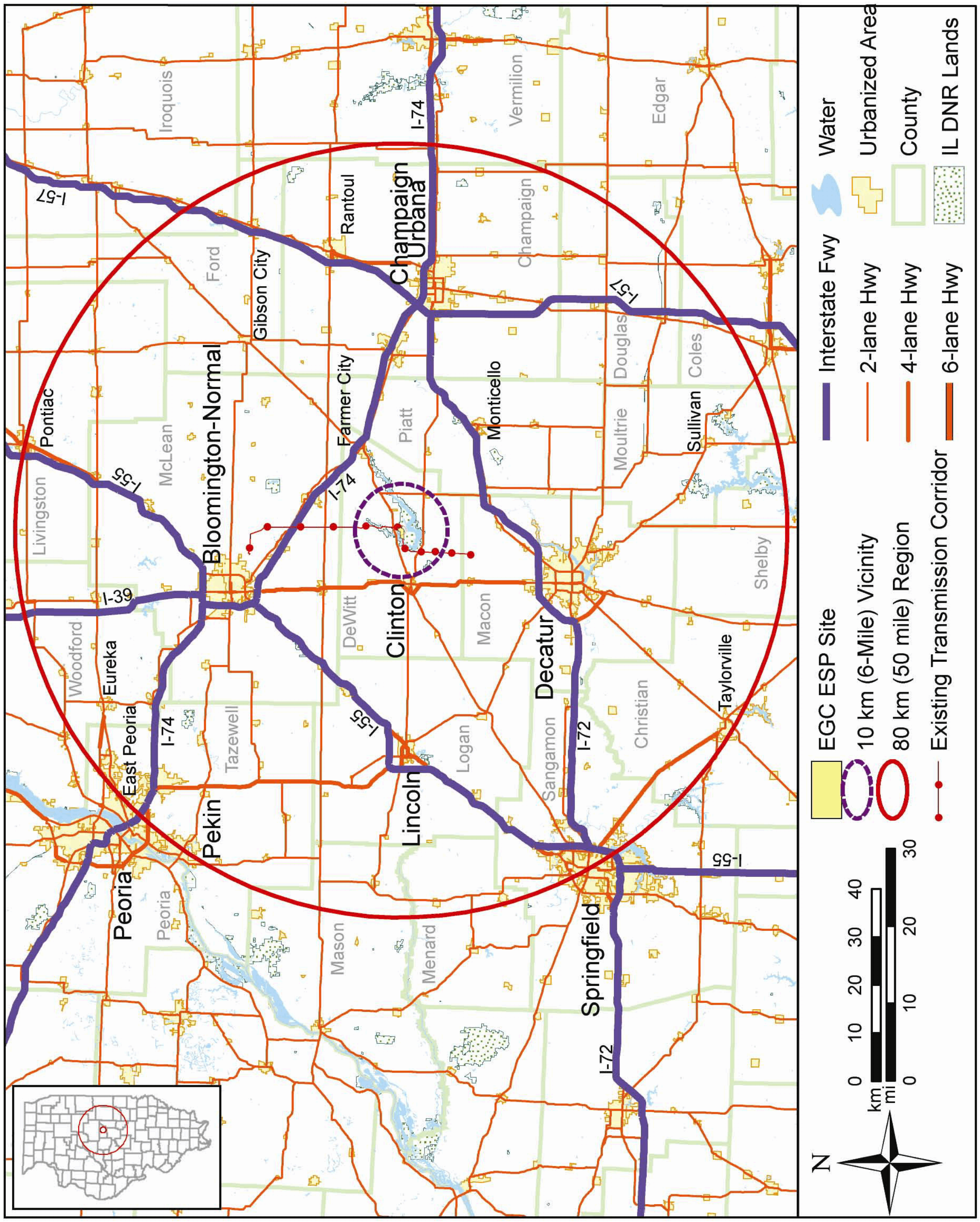

Figure 2-2. Exelon ESP 80-km (50-mi) Region

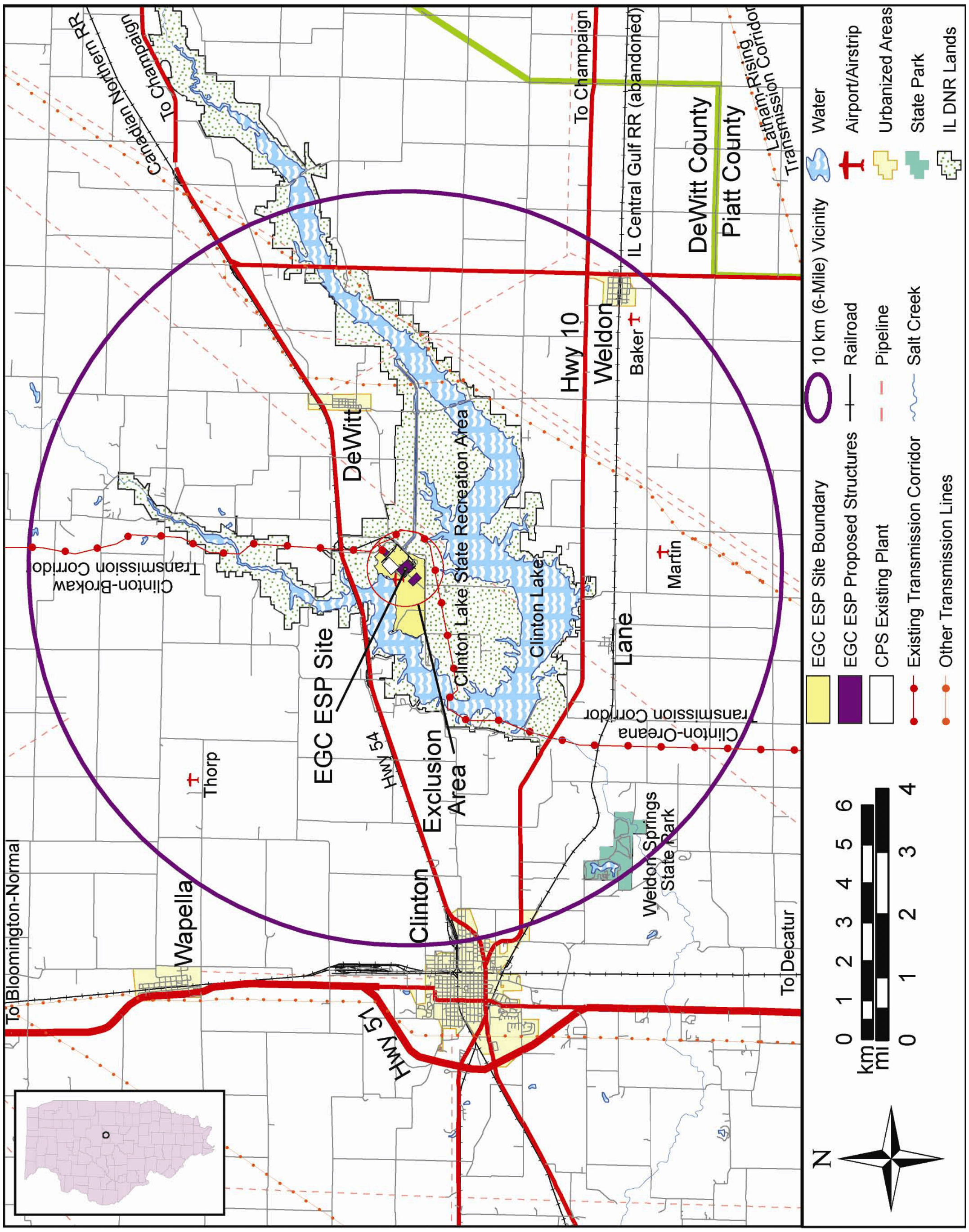

Figure 2-3. Exelon ESP 10-km (6-mi) Vicinity

In its Environmental Report (ER), Exelon states that agreements between Exelon and AmerGen will be in place to ensure that Exelon has the necessary authority, control, and rights related to the proposed ESP site (Exelon 2006a).

Clinton Lake, an artificial reservoir, was created in 1977. The lake was filled by early 1978. The lake has a storage capacity of 9.15 x 10^7 m^3 (74,200 acre-ft) at normal pool elevation. Clinton Lake was created primarily as a source of cooling water for the CPS although it has become a popular recreation area, and the dam provides downstream flood control. The lake is used as a source of potable water for the CPS. Clinton Lake is managed by the Illinois Department of Natural Resources (IDNR) through a lease agreement with AmerGen. There were 972,616 visitors to the lake during 2000 (IOC 2001).

2.2 Land

This section discusses land-related issues for the Exelon ESP site. Section 2.2.1 describes the site and the vicinity around the site. Section 2.2.2 discusses the existing transmission line rights-of-way and offsite areas. Section 2.2.3 discusses the region, defined as the area within 80 km (50 mi) of the ESP site.

2.2.1 The Site and Vicinity

For purposes of this environmental impact statement (EIS), the Exelon ESP site refers to the area that will be directly affected by construction and operation of the new nuclear unit and includes all the land area within the ESP site boundary, or approximately 187 ha (461 ac). The vicinity includes all land within a 10-km (6-mi) radius of the proposed ESP site.

The Exelon ESP site is located in DeWitt County in central Illinois, just over 10 km (6 mi) east of the city of Clinton, the county seat of DeWitt County. The proposed site lies within the existing boundaries of the current CPS site. The new nuclear unit would be sited adjacent to the existing nuclear power station.

The Exelon ESP 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 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 about 366 m (1200 ft) downstream from the confluence of Salt Creek and the Salt Creek North Fork, approximately 5 km (3 mi) to the southwest of the ESP site. Salt Creek flows southwesterly, joining the Sangamon River at a point about 85 km (53 mi) west of the site. At a normal pool elevation of 210 m (690 ft), the lake covers 1981 ha (4895 ac) and extends up Salt Creek to about 19 km (12 mi) from the dam and up the Salt Creek North Fork about 11 km (7 mi) from the dam. Most of Clinton Lake's immediate shoreline is owned by AmerGen and managed by the IDNR as the Clinton Lake State Recreation Area. Figure 2-3 illustrates the geography of the site and vicinity.

Within the ESP site, 100 percent (187 ha [461 ac]) has been graded or otherwise developed for the operation of the existing nuclear power plant. Except for the CPS plant structures, there are no industrial, residential, commercial, or institutional structures on the site. The ESP site in its entirety is zoned for transportation and industrial use. Except for the dam that was built across Salt Creek to create Clinton Lake, no structures have been built in the preconstruction 100-year floodplain of the ESP site. Several structures were built along the edges of the flood-prone area of the ESP site, including the intake and discharge structures, modified highway bridges, a marina, and seven boat ramps.

The closest communities to the ESP site include DeWitt, Lane, Weldon, and Clinton. DeWitt has a population of about 188 and is located nearly 5 km (3 mi) east of the ESP site. Lane has a population of 126 and is located just about 5 km (3 mi) south of the site. Weldon has a population of 440 and is located more than 8 km (5 mi) southeast of the site. The city of Clinton has a population of 7485, and is located more than 10 km (6 mi) west of the site. The nearest resident to the site is 1.2 km (0.73 mi) to the southwest. The nearest school is 7.7 km (4.8 mi) west of the site, the nearest church is 6.1 km (3.8 mi) south of the site, and the nearest campground is approximately 1.6 km (1 mi) west of the site (Exelon 2006a).

The ESP site vicinity is 84 percent agricultural land (24,622 ha [60,842 ac]). Industrial land use within the vicinity is less than 1 percent and is limited to areas near Clinton and Weldon. Less than 1 percent of land within the site vicinity is residential and consists primarily of residential areas in Clinton and Weldon (Exelon 2006a). There are no known significant mineral resources (e.g., sand and gravel, coal, oil, natural gas, and ores) in the vicinity of the ESP site (Exelon 2006a). Table 2-1 illustrates the land-use and land-cover characteristics of the site and vicinity.

Recreational areas are the only special land uses within the vicinity. They include the Clinton Lake State Recreation Area, the Moscoutin Recreation Site, and the Weldon Springs State Recreation Area. Clinton Lake State Recreation Area is 3764 ha (9300 ac), including the 1981-ha (4895-ac) Clinton Lake, and offers snowmobiling, ice fishing, ice skating, boating, fishing, water skiing, picnicking, camping, swimming, hiking, and hunting. Weldon Springs State Recreation Area encompasses approximately 150 ha (370 ac) and contains an 11-ha (28-ac) lake. Weldon Springs State Recreation Area offers facilities for fishing, picnicking, boating, and hiking during the summer, and sledding, tobogganing, ice fishing, and cross-country skiing during the winter.

Table 2-1. Land-Use Classification of the Exelon ESP Site and Vicinity, Region, and Potentially Affected Transmission Line Rights-of-Way[(a)]

	80-km (50-mi) Region		10-km (6-mi) Vicinity		Transmission Line Rights-of-Way	
Land-Use Class	**Area, ha (ac)**	**Percent of Total**	**Area, ha (ac)**	**Percent of Total**	**Area, ha (ac)**	**Percent of Total**
Agricultural	1,894,793 (4,682,136)	93.1	24,622 (60,842)	84.0	365 (903)	84.9
Developed Nonresidential	10,524 (26,006)	0.5	64 (158)	0.2	2 (5)	0.5
Residential	27,467 (67,873)	1.3	67 (165)	0.2	0 (0)	0.0
Undeveloped	67,090 (165,782)	3.3	2433 (6012)	8.3	49 (122)	11.5
Water or Wetlands	35,117 (86,775)	1.7	2119 (5236)	7.2	13 (33)	3.1
Total Acreage	2,034,990 (5,028,571)		29,304 (72,411)		430 (1063)	

(a) U.S. Geological Survey land-cover classes have been aggregated for presentation purposes. Rounding may affect totals. The ESP site is 187 ha (461 ac) in size and is zoned for transportation and industrial use. Land covers vary within the site. Recreation areas are not a designated land-cover class and are not separated in this table (Vogelmann et al. 2001).

The topography of the vicinity is generally flat, even to the exclusion of hedgerows and forested tracts. Along the major drainage courses, however, the land is gently rolling to steeply sloped and usually forested. Elevations range from approximately 244 m (800 ft) above mean sea level (MSL) in the north-central portion of the vicinity to 210 m (690 ft) above MSL along Clinton Lake (USGS 2001).

Figure 2-3 shows the transportation and utility networks, comprised of highways, rail lines, and utility rights-of-way, which cross the site and vicinity. Illinois Route 54 is approximately 1.6 km (1 mi) north of the ESP site. Illinois Route 10 is approximately 5 km (3 mi) south, and Illinois Route 48 is approximately 8 km (5 mi) east of the ESP site. As shown, access to the site is limited primarily by Illinois Route 54. The Canadian National Railroad runs parallel to Illinois Route 54 and traverses the vicinity approximately 1.6 km (1 mi) north of the ESP site. A rail spur from that line runs south into the ESP site. There are three private airports within the vicinity of the site: the Martin Airport is located approximately 6 km (4 mi) south of the site; the Thorp Airport is located approximately 8 km (5 mi) northwest of the site; the Baker Strip is located approximately 8 km (5 mi) southeast of the site. The waterways within the vicinity include Clinton Lake, Salt Creek, the North Fork of Salt Creek, which branches off Clinton Lake, and Weldon Springs Lake. There is one canoe access area north of the site. In addition, there is one marina with boat access south of the site, and four boat access areas, one in each cardinal direction from the site. There are no known significant mineral resources (e.g., sand and gravel, coal, oil, natural gas, and ores) in the vicinity of the ESP site (Exelon 2006a).

In 1992, DeWitt County published a comprehensive plan to guide overall development in the area. Use of the ESP site for a new nuclear unit will not conflict with proposed zoning because the facility will be constructed within the existing CPS site, which is already designated for transportation and utilities. The plan states that DeWitt County should encourage new spin-off development or related expansion at the CPS site (University of Illinois 1992).

2.2.2 Transmission Line Rights-of-Way and Offsite Areas

The anticipated transmission line rights-of-way for the Exelon ESP facility are the existing rights-of-way used to transmit power generated from the CPS. The transmission line rights-of-way are comprised of two sections. Based on geographic information system (GIS) analysis, the staff estimates the northern section is approximately 37 km (23 mi) long with a width of 76 m (250 ft) (an area of 283 ha [700 ac]). Based on the description in the ER, the staff estimates that the southern section is approximately 19 km (12 mi) long with a width of 76 m (250 ft) (an area of 147 ha [363 ac]). The northern section runs north of the ESP site, and then turns west and terminates at the Brokaw substation just west of Bloomington. The southern section runs southwest of the ESP site past Clinton Lake, and then turns south and would terminate at a point near the intersection of the Latham-Rising 384 kV transmission line. Figures 2-2 and 2-3 show the transmission line rights-of-way that are anticipated to be upgraded. Table 2-1 describes the percentage and actual area devoted to the major land-use and land-cover classifications that were confirmed with a review of aerial photographs and onsite inspection. Section 3.3 describes the specific upgrades anticipated for the transmission line rights-of-way.

Recreation areas, including the Clinton Lake State Recreation Area, are the only special land uses along the transmission line rights-of-way. Clinton Lake State Recreation Area is 3760 ha (9300 ac), which includes the 1981-ha (4895-ac) Clinton Lake. The topography of the transmission line rights-of-way is generally flat. Along the major drainage courses, however, the land is gently rolling to steeply sloped and usually forested. Elevation ranges from approximately 240 m (800 ft) above MSL in the north-central portion of the transmission rights-of-way to 210 m (690 ft) above MSL near Clinton Lake.

Figure 2-3 shows the transportation network, including highways and rail lines that cross the transmission line rights-of-way. The highways that traverse the transmission line rights-of-way are U.S. Highway 150, Interstate 74, U.S. Highway 136, Illinois SR 54, and Illinois SR 10. The

Norfolk Southern Railroad traverses the northern portion of the transmission line right-of-way. The railroad also has a line that runs parallel to Interstate 74 and traverses the north-central portion of the transmission line rights-of-way. The Canadian National Railroad runs parallel to Illinois SR 54 and traverses the transmission line right-of-way approximately 1.6 km (1 mi) north of the ESP site. There are three private airports and one public airport within 2.4 km (1.5 mi) of the transmission line rights-of-way. The public airport is Bloomington-Normal Airport, located approximately 1.6 km (1 mi) west of the northern tip of the transmission line right-of-way. The private airports include the Martin Airport, Thorp Airport, and the Baker Strip, discussed previously in Section 2.1.

The waterways that the transmission line rights-of-way cross include Clinton Lake, Salt Creek, and North Fork Salt Creek. There is one canoe access area near the northern section of the transmission line right-of-way that crosses Salt Creek. The southern section of the transmission line right-of-way crosses Salt Creek below Clinton Lake Dam, near a recreation site on the creek. There are no known significant mineral resources (sand and gravel, coal oil, natural gas, or ores) within the transmission line rights-of-way (Exelon 2006a).

The comprehensive plan published in DeWitt County in 1992 (University of Illinois 1992) indicates that the transmission line rights-of-way do not conflict with any proposed zoning for the county. DeWitt County has designated an area approximately 1.6 km (1 mi) southwest of the CPS and Clinton Lake as a possible area for a new restaurant and a golf course. Bicycle and hiking trails are planned along the Canadian National Railroad. The transmission line rights-of-way would not interfere with the county's land-use plan because only existing rights-of-way are anticipated to be used for a new nuclear unit at the Clinton ESP site.

McLean County published a regional comprehensive plan in August 1999 (McLean County 1999). The transmission line rights-of-way would not conflict with any proposed zoning for the county. McLean County plans to make some improvements to the roads that either cross or are adjacent to the transmission line rights-of-way. The transmission line right-of-way would not interfere with the county's land-use plan because only an existing right-of-way is anticipated to be used for a new nuclear unit at the Clinton ESP site.

2.2.3 The Region

The region, defined as the area extending 80 km (50 mi) from the ESP unit centerpoint, includes all or portions of the following counties in Illinois: Champaign, Christian, Coles, DeWitt, Douglas, Ford, Iroquois, Livingston, Logan, Macon, Mason, McLean, Menard, Moultrie, Piatt, Sangamon, Shelby, Tazewell, Vermilion, and Woodford. Major land-use classifications, waterways, recreation areas, highways, roads, and other transportation routes in the region are shown in Figure 2-2.

Regionally, the Exelon ESP site lies approximately 82 km (51 mi) northeast of Springfield, Illinois, 48 km (30 mi) west of Champaign, Illinois, 35 km (22 mi) southeast of Bloomington, Illinois, and about 200 km (125 mi) south of Chicago, Illinois. The site is near the center of a triangle formed by the large cities of Bloomington-Normal, Champaign-Urbana, and Springfield, Illinois. Interstates 74 and 72 pass within 18 km (11 mi) to the northwest and 19 km (12 mi) to the southwest of the site, respectively. Illinois SR 51 passes about 11 km (7 mi) west of the site. Figure 2-2 illustrates the extent of the region considered in this EIS.

Land use within the region varies with distance from major population centers and high-use transportation corridors. The metropolitan areas of Springfield, Bloomington-Normal, and Champaign-Urbana contain the highest density of residential, commercial, and industrial land use. Land use in the immediate vicinity of the ESP site and the areas outside the noted metropolitan areas and transportation corridors is primarily agricultural, with several small towns and communities. The region, comprising about 14.2 percent of the total area of Illinois, encompasses four main land-use classes (Exelon 2006a). Cropland covers the vast majority of the land area in the region, followed by urbanized areas, forested riparian areas, and park and recreation area reserves. Table 2-2 identifies agricultural land use by major crop in the affected region. Table 2-3 provides information on the region's livestock production.

There are four airports with scheduled passenger air service within the region: Springfield Capital Airport, Decatur Airport, Central Illinois Regional Airport in Bloomington, and the University of Illinois-Willard Airport in Champaign. The Rantoul National Aviation Center - Frank Elliot Field, formerly the Chanute Air Force Base, lies about 61 km (38 mi) northwest of the ESP site.

Much of the region comes under the Illinois Governor's Office regional plan for the North-Central Region of the State, which covers DeWitt, Fulton, Livingston, Marshall, Mason, McLean, Peoria, Stark, Tazewell, and Woodford Counties. The Governor's "Opportunity Returns" plan for North Central Illinois (State of Illinois 2003) consists of five primary goals to address the economic and workforce development needs of the region: investing in entrepreneurship and innovation, improving transportation infrastructure, strengthening education and job training, investing in renewable energy and the environment, and encouraging investment and opening markets.

Table 2-2. 2002 Major Agricultural Crops and Land in Production within 80 km (50 mi) of the Exelon ESP Site (hectares [acres])

County (Illinois)	Total Land Area	Harvested Area of Major Crops: All Hay	Oats	Corn (Grain)	Corn (Other)	Soybeans	All Wheat	Major Crop Land Harvested	Total Land in Crop Production
Champaign	258,172	1390	163	112,311	67	104,803	973	219,707	226,320
	(637,956)	(3434)	(403)	(277,527)	(165)	(258,974)	(2405)	(542,908)	(559,248)
Christian	183,646	1334	255	79,343	73	71,380	1146	153,531	157,575
	(453,799)	(3297)	(629)	(196,060)	(180)	(176,385)	(2833)	(379,384)	(389,376)
Coles	131,645	2232	16	44,498	129	45,829	494	93,199	96,552
	(325,303)	(5516)	(40)	(109,957)	(319)	(113,246)	(1221)	(230,299)	(238,586)
De Witt	102,972	989	66	38,178	33	37,105	116	76,486	78,027
	(254,449)	(2443)	(162)	(94,339)	(82)	(91,689)	(286)	(189,001)	(192,809)
Douglas	107,967	1461	370	43,851	298	42,097	197	88,273	90,327
	(266,792)	(3609)	(914)	(108,357)	(736)	(104,025)	(487)	(218,128)	(223,202)
Ford	125,847	473	141	53,967	77	53,662	918	109,238	111,923
	(310,975)	(1168)	(348)	(133,356)	(191)	(132,601)	(2269)	(269,933)	(276,567)
Iroquois	289,154	2805	283	129,532	541	119,403	1453	254,018	262,401
	(714,514)	(6932)	(699)	(320,080)	(1338)	(295,052)	(3591)	(627,692)	(648,406)
Livingston	270,332	1776	422	118,664	251	119,564	1974	242,652	247,639
	(668,006)	(4389)	(1044)	(293,226)	(620)	(295,449)	(4878)	(599,606)	(611,929)
Logan	160,098	1189	143	69,406	133	63,337	343	134,551	138,763
	(395,610)	(2938)	(354)	(171,505)	(329)	(156,508)	(848)	(332,482)	(342,890)
Macon	150,355	720	78	61,119	11	57,945	99	119,971	122,554
	(371,535)	(1778)	(193)	(151,029)	(26)	(143,185)	(244)	(296,455)	(302,838)
Mason	139,585	1586	226	47,129	8	37,675	2186	88,810	105,092
	(344,923)	(3919)	(558)	(116,459)	(20)	(93,096)	(5402)	(219,454)	(259,687)

Table 2-2. (contd)

County (Illinois)	Total Land Area	Harvested Area of Major Crops						Major Crop Land Harvested	Total Land in Crop Production
		All Hay	Oats	Corn (Grain)	Corn (Other)	Soybeans	All Wheat		
McLean	306,532	1936	254	132,320	671	124,919	407	260,507	266,859
	(757,457)	(4783)	(627)	(326,970)	(1659)	(308,682)	(1005)	(643,726)	(659,423)
Menard	81,390	963	7	26,336	94	24,148	538	52,085	56,463
	(201,118)	(2379)	(17)	(65,078)	(232)	(59,670)	(1329)	(128,705)	(139,523)
Moultrie	86,919	1153	222	34,852	275	33,563	314	70,379	71,561
	(214,781)	(2848)	(548)	(86,121)	(679)	(82,937)	(777)	(173,910)	(176,831)
Piatt	113,965	390	47	51,236	56	47,868	219	99,816	101,603
	(281,614)	(964)	(115)	(126,608)	(139)	(118,285)	(540)	(246,651)	(251,066)
Sangamon	224,858	2416	45	95,081	83	71,977	292	169,894	176,634
	(555,636)	(5971)	(110)	(234,951)	(205)	(177,858)	(721)	(419,816)	(436,471)
Shelby	196,453	4336	65	67,463	1070	68,140	5293	146,367	151,681
	(485,447)	(10,715)	(161)	(166,704)	(2643)	(168,378)	(13,080)	(361,681)	(374,811)
Tazewell	168,054	2097	180	58,595	196	52,017	962	114,048	122,203
	(415,270)	(5183)	(445)	(144,791)	(485)	(128,538)	(2377)	(281,819)	(301,970)
Vermilion	232,861	2211	135	83,319	146	81,727	758	168,297	173,571
	(575,411)	(5464)	(334)	(205,886)	(360)	(201,953)	(1874)	(415,871)	(428,904)
Woodford	136,738	1742	288	55,879	91	51,754	923	110,677	114,715
	(337,888)	(4305)	(712)	(138,079)	(226)	(127,886)	(2280)	(273,488)	(283,467)
Region	3,330,804	31,456	3116	1,347,200	4212	1,257,160	18,683	2,661,828	2,757,745
	(8,230,596)	(77,730)	(7701)	(3,329,004)	(10,408)	(3,106,511)	(46,167)	(6,577,521)	(6,814,537)

Source: USDA 2004

Table 2-3. 2002 Livestock Production and Farm Value within 80 km (50 mi) of the Exelon ESP Site

	Livestock Inventory				Farm Inventory		
County	Beef Cattle (Head)	Milk Cows (Head)	Hogs and Pigs (Head)	Chickens Sold (Number)	Farms	Average Value per Farm ($)	Average Value per Acre ($)
Champaign	(a)	(a)	21,158	412	1285	1,416,465	2890
Christian	2852	11	27,742	(a)	796	1,468,856	2530
Coles	2446	220	3058	470	684	1,074,094	2716
DeWitt	(a)	(a)	22,107	383	459	1,542,195	3012
Douglas	374	1469	8,863	48,597	576	1,200,817	2970
Ford	594	12	29,874	0	530	1,575,153	2608
Iroquois	3667	1007	32,137	1038	1386	1,287,988	2402
Livingston	1497	812	125,275	550	1330	1,388,250	2658
Logan	(a)	(a)	80,755	(a)	692	1,522,254	2808
Macon	(a)	(a)	6397	(a)	646	1,636,567	3057
Mason	3154	0	13,521	(a)	443	1,570,696	2183
McLean	3884	2840	92,321	(a)	1442	1,398,865	2912
Menard	2475	109	30,859	(a)	329	1,255,196	2421
Moultrie	943	1111	9346	(a)	441	1,267,450	2952
Piatt	701	113	8072	30	442	1,999,015	2981
Sangamon	4499	252	50,810	40	970	1,451,434	2829
Shelby	6120	2375	56,285	0	1228	879,981	2341
Tazewell	3513	608	74,762	240	918	1,095,311	2862
Vermilion	3031	167	19,056	241	909	1,403,687	2467
Woodford	3240	205	82,337	(a)	919	1,127,894	2993
Region	42,990	11,311	794,735	52,001	16,425	1,414,745	2708

Note: (a) Value not disclosed by US Dept of Agriculture, not included in totals.
Source: USDA 2004

2.3 Meteorology and Air Quality

The following three sections describe the climate and air quality of the Exelon ESP site. Section 2.3.1 describes the climate of the region and area in the immediate vicinity of the ESP site. Section 2.3.2 describes the air quality in the region. Section 2.3.3 describes the meteorological monitoring program at the site.

2.3.1 Climate

The Exelon ESP site has a typical continental climate with moderately cold winters and warm summers. Air masses may approach the region from the south, west, or north. The closest first-order weather stations with long periods of record are Peoria, about 88 km (55 mi) northwest of the site, and Springfield, about 79 km (49 mi) west-southwest of the site. These stations provide a good indication of the general climate at the ESP site because of their proximity and similarities in topography and vegetation. The ESP site is relatively flat with no topographic features that would cause the local climate to deviate significantly from the regional climate.

The following climatological statistics are derived from local climatological data for Peoria and Springfield (NCDC 2004a, b). Temperatures are more variable in the winter than in the summer because of the differences in air mass source regions. Day time maximum temperatures range from about 0°C (32°F) in January to about 30°C (86°F) in July, while night time minimum temperatures range from about -9°C (16°F) in January to about 19°C (65°F) in July. Monthly average wind speeds range from about 3.5 m/s (8 mph) in the summer to about 5 m/s (12 mph) in the winter and early spring. Precipitation is rather uniformly distributed throughout the year with an average of 7.5 cm (3 in.) or more of rain falling each month from March through September. Snow generally occurs between November and March with the month of January having an average snowfall of about 20 cm (7.8 in.).

Relative humidity generally varies diurnally with a maximum in the early morning hours and a minimum in the afternoon. Regionally, the noon relative humidity ranges from about 70 percent in the winter to about 55 percent in the early spring and fall. During the summer, the noon relative humidity is about 60 percent. On about 20 days per year, the air becomes saturated and fog forms, which limits the visibility to less than 400 m (0.25 mi).

2.3.1.1 Wind

Regionally, the prevailing wind directions in Peoria and Springfield in all months are from the south. Wind speeds in Peoria range from about 3.2 m/s (7.1 mph) in August to about 5.2 m/s (12 mph) in March. Monthly average wind speeds in Springfield range from 3.4 m/s (7.7 mph) in August to 5.8 m/s (13 mph) in March (NCDC 2004a, b). Winds measured onsite by the CPS meteorological system from April 1972 through April 1977 and January 2000 through August 2002, indicate that the dominant wind direction at the site is from the south. The annual average wind speed for the site is about 4.2 m/s (9.3 mph) (Exelon 2006a).

Wind persistence at the site was evaluated using the 1972 through 1977 data. The maximum persistence period of 33 hours occurred twice. During one period, the wind was from the south-southwest, and during the other it was from the northeast (Exelon 2006a).

2.3.1.2 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 based on temperature differences is set forth in Safety Guide 23 (AEC 1972). When the temperature decreases rapidly with increasing height, the atmosphere is unstable and atmospheric dispersion is good. In contrast, when the temperature increases with height, the atmosphere is stable and dispersion is limited.

Temperature difference measurements made on the CPS meteorological tower indicate that unstable atmospheric conditions exist at the site approximately 18 percent of the time, and stable conditions exist about 44 percent of the time (Exelon 2006a). During the remaining 38 percent of the time, the atmospheric stability is neutral, and atmospheric dispersion is moderate.

Comparison of the atmospheric stability distributions for the 1972 to 1977 and the 2000 to 2002 measurement periods indicates that there may have been a shift in the distribution toward unstable conditions between the earlier period and the later period. It is unlikely that such a shift would be a natural occurrence. It is more likely that the lower level of the temperature difference measurement system may be affected by Clinton Lake, which is heated by the cooling water from the CPS. Clinton Lake was not created until 1977, and it was not heated until 1987.

2.3.1.3 Temperature

The temperature measured at the 10-m (33 ft) level of the CPS meteorological tower is considered to be representative of the ESP site. Temperature data from the tower for the 1972 through 1977 time period show the daily average temperature ranges from a low of -5.1°C (23°F) in January to a high of 23.6°C (74.5°F) in July. During this 5-year period, the absolute minimum temperature was -28.8°C (-19.8°F), and the absolute maximum temperature was 35.2°C (95.4°F). These temperatures are consistent with long-term values for Peoria and Springfield.

2.3.1.4 Atmospheric Moisture

The moisture content of the atmosphere can be represented in a variety of ways. The most common are relative humidity, precipitation, and fog. Precipitation is measured at the CPS site, but relative humidity and fog are not.

During the 1972 through 1977 period, the annual average precipitation at the CPS was about 65 cm (25.5 in.), with monthly averages ranging from about 3.0 cm (1.2 in.) in February to about

10.7 cm (4.2 in.) in June. These values are consistent with averages for Springfield. Precipitation was recorded for about 4 percent of the hours. The maximum number of consecutive hours with precipitation was 14, and the maximum number of consecutive hours without precipitation was 807.

The CPS meteorological system does not measure relative humidity, but it does measure the dew point temperature. The dew point temperature is the temperature at which air becomes saturated when it is cooled, i.e., the relative humidity becomes 100 percent when air is cooled to the dew point. The ambient temperature and dew point temperature can be used in the design of wet cooling systems, and the difference between the temperature and dew point can be used to predict the occurrence of fog.

Climatological records at Peoria and Springfield indicate that fog occurs on an average of two to three times per month from November through March and on an average of about one day per month for the remainder of the year. These records are representative of the conditions in Dewitt County. However, they may not be representative of conditions in the immediate vicinity of the site. The site is surrounded by Clinton Lake, which is heated by the existing CPS. The potential effects on fog from the heated water in the lake and in the flume leading from the CPS to the lake have been analytically estimated (AmerGen 2001c). Based on the analytical model, several hundred hours of fog are expected on roads in the vicinity of the site, but this fog is not expected to extend beyond about 1.6 km (1 mi) from the lake, and icing on roads is not expected to extend more than 150 m (500 ft) from the lake.

2.3.1.5 Severe Weather

The site can experience severe weather in the form of thunderstorms, hail, tornadoes, and snow and ice. Thunderstorms occur on about 47 days per year with an average of more than five thunderstorm days per month from April through August. Over the last 10 years, DeWitt County, which includes the Exelon ESP site, along with Macon and McLean Counties have averaged more than one hail storm with hail size of at least 1.9 cm (0.75 in.) per year (NCDC 2004c).

From 1950 through 2003, 18 tornadoes were reported in DeWitt County (NCDC 2004c), including one magnitude F4 tornado (wind speed between 92 and 116 m/s [207 and 260 mph]). Using tornado data for the period from January 1, 1950, through August 31, 2003, the best estimate tornado strike probability and 10^{-7} probability design wind speed for the Exelon ESP site are 1.2×10^{-3} per year and 134 m/s (300 mph), respectively (Ramsdell 2004).

The average snowfall in the area is about 64 cm (25 in.) with most of the snow falling in December, January, and February. About twice each winter, there is a heavy snow storm, ice storm, or other winter storm of note (NCDC 2004c). These storms generally cover much of central Illinois.

2.3.2 Air Quality

The Exelon ESP site is in DeWitt County, Illinois, which is on the western edge of the East Central Illinois Intrastate Air Quality Control Region (AQCR). The West Central Illinois Intrastate AQCR lies to the south and west of DeWitt County, and the Burlington-Keokuk Interstate AQCR lies northwest of DeWitt County. All of the counties in these AQCRs near the ESP site are in compliance with the National Ambient Air Quality Standards (40 CFR 81.314). There are no mandatory Class 1 Federal Areas where visibility is an important value in Illinois or Indiana within 160 km (100 mi) of the ESP site.

The Illinois Environmental Protection Agency (IEPA) operates a statewide air-monitoring network comprising 41 sites. However, none of the monitoring stations is in DeWitt County. The closest monitoring stations are in Normal and Decatur, and slightly more distant stations are located in the Peoria, Springfield, and Champaign-Urbana areas. Results of monitoring at these locations show that there were no days on which the National Ambient Air Quality Standards for sulfur dioxide, nitrogen dioxide, and particulate matter were exceeded (IEPA 2003). Similarly, there were no days on which the new 1-hour ozone standard was exceeded. However, the 8-hour ozone standard was exceeded on 4 days each at the Normal and Decatur monitoring locations, on 1 day in the Champaign-Urbana area, and on 2 days in the Peoria area.

Statewide monitoring data for the last 10 years indicate that the air quality in 2002 was generally consistent with air quality in recent years (IEPA 2003). Where air quality trends appear to exist, they indicate that air quality in Illinois is improving.

The Air Quality Index (AQI) is a national standard method for reporting air-pollution levels for the general public. The AQI is based on comparison of the concentrations of six pollutants with National Ambient Air Quality Standards. The six pollutants are ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter smaller than 10 micrometers (PM_{10}), and particulate matter smaller than 2.5 micrometers ($PM_{2.5}$). The air-pollution level for each day is placed in one of six categories based on the AQI. In order of decreasing air quality, the categories are Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, and Hazardous.

According to the IEPA (IEPA 2003), there were no days in 2002 in which the air quality was classified as Unhealthy, Very Unhealthy, or Hazardous in the vicinity of DeWitt County. The air quality was classified as Unhealthy for Sensitive Groups on 5 days in the Bloomington-Normal area, 4 days in Decatur, 3 days in Peoria, and 1 day in the Champaign-Urbana area. For the remainder of the time, the air quality was classified as Good or Moderate, with Good days far outnumbering Moderate days.

All of the areas for which there are monitoring data and AQIs are more densely populated than DeWitt County and the area around the ESP site. Consequently, air quality at the site should be better than indicated by the monitoring data and AQIs.

2.3.3 Meteorological Monitoring

There has been a meteorological monitoring program at the Exelon ESP site since April 1972. The initial instrumentation was installed to provide the onsite meteorological information required for licensing of the CPS. It has continued in operation in support of the CPS. The instrumentation is described briefly in the CPS Final Environmental Statement (AEC 1974), in more detail in the CPS Updated Safety Analysis Report (AmerGen 2001c), and in the ER for the ESP site (Exelon 2006a).

The meteorological monitoring system consists of a 60-m (199-ft) tower located approximately 550 m (1800 ft) south-southeast of the center of the ESP power block footprint, meteorological instrumentation located on and near the tower, and signal conditioning and recording equipment. Wind, temperature (or temperature difference), and dew point are measured at the 10- and 60-m (33- and 199-ft) levels of the tower. Precipitation is measured at ground level near the base of the tower. Data from the instruments were initially recorded on strip charts and then manually transferred to punch cards. Data are now recorded on strip charts in the control room and fed to a microprocessor that records the data electronically. Backup wind instruments are located at the 10-m (33-ft) level of a microwave tower about 1160 m (3800 ft) north of the center of the ESP power block footprint.

Instruments and other components of the meteorological system have been replaced periodically over the years, but the basic meteorological system has remained essentially the same as the system installed in 1972. A major upgrade of the system is planned for the near future.

Atmospheric dispersion factors (χ/Q values) are used to evaluate the potential consequences of routine and accidental releases at the ESP site. Meteorological data of the period from January 2000 through August 2002 were used to develop atmospheric dispersion factors for comparison with the atmospheric data Exelon presented in its ER. Exelon (Exelon 2006a) provided the staff with meteorological data for the full 3-year period from January 2000 through December 2003. The staff used these data to estimate atmospheric dispersion factors for comparison with those presented in the ER.

The staff viewed the meteorological site and instrumentation, reviewed the available information on the meteorological measurement program, and evaluated data collected by the program. Based on this information, the staff concludes that the program provides data that represent the onsite meteorological conditions as required by 10 CFR 100.20. The data also provide an acceptable basis for making estimates of atmospheric dispersion for the evaluation of the consequences of routine and accidental releases required by 10 CFR 50.34 and 10 CFR Part 50, Appendix I.

2.4 Geology

A detailed description of the geological, seismological, and geotechnical conditions at the proposed site is provided in the Site Safety Analysis Report (Exelon 2006c). A brief summary of the geology of the proposed ESP site is provided in Section 2.6 of the ER submitted by Exelon (Exelon 2006a). This description was based in part on earlier reports prepared for the existing units at the site. Additionally, results of subsurface investigations performed recently as part of the ESP application provided further basis for this description. The staff's description of the site and vicinity geological features and the detailed analyses and evaluation of geological, seismological, and geotechnical data as required for an assessment of the site-safety issues related to the specific proposed ESP site is included in the staff's safety evaluation report.

The Exelon ESP site lies 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.

Groundwater aquifers in the region of the ESP site are described by Exelon in Section 2.3.1.3 of its ER (Exelon 2006a). 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. At the ESP site, loess and alluvium along the floodplains overlays glacial drift deposits. Based on Exelon's borings at the site location, the glacial drift is generally more than 61 m (200 ft) thick beneath the site.

The Illinois State Geologic Survey identified the Parnell and Wapella E. oil fields in the vicinity of the proposed site but none beneath it (ISGS 2006). No known mining activities would likely be precluded from the granting of an ESP.

Geotechnical properties of the glacial material beneath the site would be unsuitable for use as a fill material for plant construction. Therefore, fill material would need to be imported to the ESP site during construction and excavated material would have to be removed to another location, either on or off the site. Assuming best management construction practices would be employed, the low-relief terrain and geotechnical properties of the surficial materials make significant landslides in the region of the site unlikely.

2.5 Radiological Environment

A radiological environmental monitoring program (REMP) has been conducted around the CPS site since 1980 (AmerGen 2000a). The REMP includes the following pathways: direct radiation, atmospheric, aquatic, and terrestrial environments, and ground and surface water. A pre-operational environmental operating program was conducted from 1980 to 1987 to establish a baseline to observe fluctuations of radioactivity in the environment after operations began. After routine operation of Unit 1 started in 1987, the monitoring program continued to assess the radiological impacts to workers, the public, and the environment. The results of this monitoring are documented in an annual environmental operating report for CPS. The U.S. Nuclear Regulatory Commission (NRC) staff reviewed historical data from the REMP reports for a 4-year period (1999-2002) and found that environmental measurements of this time period were similar to those during the preoperational monitoring phase (AmerGen 2000a, 2001b, 2002b, 2003).

Each year, AmerGen issues a report entitled *Annual Radioactive Effluent Release Report for the Clinton Power Station*, which documents gaseous and liquid releases and resulting doses from the CPS. The NRC staff reviewed annual radioactive effluent release reports for calendar years 1999, 2000, and 2001 (AmerGen 2000b, 2001a, 2002a). Maximum doses to a member of the public were calculated using effluent concentration and historical meteorological data for the site. For the 3 years reviewed, the maximum annual dose to a member of the public was less than 3×10^{-5} mSv (less than 0.003 mrem). The data showed that doses to the maximally exposed individuals around CPS were a small fraction of the limits specified in Federal environmental radiation standards, 10 CFR Part 20; 10 CFR Part 50, Appendix I; and 40 CFR Part 190.

2.6 Water

This section describes the hydrologic features and processes governing movement and distribution of water in the existing environment at the Exelon ESP site. Two circumstances were considered: (1) the existing unit in operation and (2) the existing unit not in operation. The most limiting of circumstances is the existing environment with the current unit in operation, and, unless mentioned otherwise, it is this scenario that is used throughout this analysis.

2.6.1 Hydrology

This section describes site-specific and regional hydrological features of the existing environment that could be altered by construction, operation, or decommissioning of a new nuclear unit at the ESP site. A description of the site's hydrological features is presented in

Section 2.3.1 of the ER (Exelon 2006a). Hydrological features of the site related to site safety (e.g., probable maximum flood) are described in the Site Safety Analysis Report portion of the application.

2.6.1.1 Surface-Water Hydrology

The dominant hydrological feature of the Exelon ESP site is Clinton Lake. The site is located between the two main arms of Clinton Lake, which was created by impounding Salt Creek and the North Fork of Salt Creek behind a dam 366 m (1200 ft) downstream from the historical confluence of the two streams. The pool formed behind Clinton Lake Dam has a volume of 9.15×10^7 m^3 (74,200 acre-ft) at the normal pool level elevation of 210 m (690 ft) above MSL. The normal pool level is the height of the crest of the service spillway. An additional 7.29×10^7 m^3 (59,100 acre-ft) are available for flood-control storage up to the crest of the auxiliary spillway at elevation 213 m (700 ft) above MSL. Three sluice gates located near the service spillway are used to provide the minimum downstream release from Clinton Lake.

The lake has two arms with the dam at the western end of the lake. The Salt Creek arm is larger than the North Fork of the Salt Creek arm. The existing CPS and the ESP site are located on the peninsula between the two arms. The CPS unit withdraws cooling water from the North Fork arm and returns it to 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 surface area of the lake is 1981 ha (4895 ac) at normal pool elevation.

The watershed above Clinton Lake drains 476 km^2 (296 mi^2) of predominately agricultural fields with very little relief. Water released from Clinton Lake Dam continues to flow down Salt Creek until it joins the Sagamon River. Pursuant to the CPS National Pollutant Discharge Elimination System (NPDES) permit, IEPA currently requires a minimum release of 0.14 m^3/s (5 cfs) from the Clinton Lake Dam.

Evaporation from the large surface area of Clinton Lake reduces the total amount of water available to flow downstream of the dam. The average annual evaporation reported by Roberts and Stall (1967) for reservoirs in nearby Peoria and Springfield is 90.68 and 90.62 cm (35.70 and 35.68 in.), respectively. The maximum monthly average evaporation for these two locations occurs in July with monthly evaporation values of 16.28 and 16.13 cm (6.41 and 6.35 in.), respectively. The minimum monthly average evaporation for these two locations occurs in January with monthly evaporation values of 1.12 and 1.22 cm (0.44 and 0.48 in.), respectively. 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 the existing CPS unit. 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 has inundated.

Therefore, the presence of the lake and the discharge of heat to the lake from the existing CPS unit have increased evaporation and reduced the total quantity of water available for release downstream of the dam. It should be noted, however, that the dam provides a beneficial flow stabilization impact, and historical pre-dam minimum flows were less than the current post-dam minimum discharges released from the dam, frequently less than 0.14 m^3/s (5 cfs) during dry summer months.

In an average year in the watershed, precipitation approximately equals natural evaporation. Mean annual precipitation for Peoria, Illinois, is reported as 89 cm (35 in.) (van der Leeden et al. 1990). However, in drought years, the decrease in precipitation is often paired with an increase in evaporation resulting in significant water deficits.

Seasonal patterns of precipitation and evaporation also impact water availability. While July is the month of maximum precipitation, 10.13 cm (3.99 in.), the natural lake evaporation in July is significantly greater, 16.28 cm (6.41 in.). On a monthly average basis, natural evaporation exceeds precipitation in May through August.

2.6.1.2 Groundwater Hydrology

The groundwater aquifers in the region of the ESP site are described in Section 2.3.1.3 of the ER (Exelon 2006a). The ESP site lies within the Central Lowlands Physiographic Province. Aquifers in the Central Lowlands occur in unconsolidated sand and gravel of the Quaternary age and consolidated sandstone, limestone, and dolomite of the Paleozoic age. At the ESP site, alluvium along the floodplains overlays glacial drift deposits. Based on Exelon's borings at the site location, the glacial drift is generally more than 61 m (200 ft) thick beneath the site. Exelon reports that a test well completed during the planning stage for the existing unit had high methane levels dissolved in the water. Based on the methane issue and the availability of surface water from Clinton Lake, it was decided not to use groundwater for the existing unit.

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. No aquifers in Illinois have been designated as sole-source aquifers (EPA 2004).

2.6.1.3 Hydrological Monitoring

This section describes the pre-application hydrological monitoring programs. Thermal and chemical monitoring programs are discussed in Sections 2.6.3.3 and 2.6.3.4, respectively.

As a result of ongoing monitoring associated with the existing CPS unit, Exelon was able to consider the information from this existing monitoring program as part of the pre-application monitoring program for the ESP site. Many of these same monitoring activities would likely be continued if the ESP unit was constructed and would become part of the construction and operational monitoring for a new nuclear unit. Flow measurements directly associated with current site operation are required under the terms of the CPS existing NPDES permit. Exelon proposes to: (1) augment the groundwater and aquifer characterization program performed before construction of the CPS unit, (2) design and implement a groundwater monitoring program prior to construction and (3) continue its recent subsurface investigations conducted in 2002 with additional piezometers and test wells to more accurately assess the impact of unit construction and operation on local groundwater users.

Since 1942, the U.S. Geological Survey has maintained a streamflow gauge downstream of Clinton Lake at Rowell, Illinois. There are no streamflow gauges upstream of Clinton Lake. Because of the absence of inflow data, it is not possible to create a reliable water budget for Clinton Lake directly from inflow and discharge measurements.

No water velocity measurements within Clinton Lake have been reported by Exelon. Velocity measurements are important both for understanding the hydrodynamics of the lake and calibrating numerical models of fluid and heat transport process in the lake. The lack of these measurements limits detailed process modeling of lake temperature and elevation levels. Exelon has committed to collecting current velocity measurements concurrently with monthly thermal and chemical monitoring. These measurements including inflow discharge to the lake, would become part of the Exelon's pre-application (referring to the construction permit [CP] or combined operating license [COL] application) monitoring program (Exelon 2006a). Exelon has also committed to collect bathymetric transects of the lake and record daily lake pool elevation and discharge data at the dam as part of this pre-application monitoring program.

2.6.2 Water Use

Consideration of water use requires estimating the magnitude and timing of consumptive and non-consumptive water use. Non-consumptive water use does not result in a reduction in the water supply available. For instance, water used to rinse fish impinged on intake screens off the screens would result in no change in the water supply, as the same volume of water pumped from the lake would eventually be returned to the lake. However, consumptive water use results in a reduction of the water supply available. For instance, lake evaporation results in a transfer of water from the lake to the atmosphere, thereby reducing the lake volume. The following two sections describe existing consumptive and non-consumptive uses of surface water and groundwater.

2.6.2.1 Surface-Water Use

The existing CPS unit is the only significant consumptive and non-consumptive water user of Clinton Lake. In the ER, Exelon stated that when the CPS unit is operating, pumps draw water from Clinton Lake at a rate of 35,700 L/s (566,000 gpm) in the summer and 28,075 L/s (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 does result in some induced evaporative losses from Clinton Lake.

In Section 2.3 of its ER, Exelon identified no domestic surface-water users either upstream or downstream from Clinton Lake other than the CPS unit. Clinton Lake was constructed as a cooling water source for the original two proposed CPS units.

Increases in urban development generally result in increased areas of impervious surface. Impervious surface results in less groundwater recharge and higher fractions of surface water runoff. Due to the limited projected development in the upstream drainage and policies promoting the use of storm water management practices that limit the impact of impervious surfaces, upstream land-use changes are not expected to appreciably alter the patterns of inflow to Clinton Lake.

2.6.2.2 Groundwater Use

Exelon describes groundwater use in the vicinity of the ESP site in Section 2.3.2.3 of the ER (Exelon 2006a). Groundwater is used for public water supplies and agricultural demands throughout the vicinity. Exelon reports that 65 percent of the total public groundwater supplies within a 24-km (15-mi) radius of the ESP site are pumped from the Mahomet Bedrock Valley aquifer. The remaining wells, except for wells at Heyworth (19.2 km [12 mi] northwest of the site), that pump from alluvial deposits, are pumped from glacial deposits.

2.6.3 Water Quality

The following sections describe the water quality of surface-water and groundwater resources in the vicinity of the ESP site. Pre-application monitoring programs for thermal and chemical water quality are also described.

2.6.3.1 Surface-Water Quality

This section describes the surface-water quality of Clinton Lake, the tributaries draining into Clinton Lake, and Salt Creek downstream of the lake. Exelon presents a discussion of the water quality conditions in Sections 2.3.3.1 and 2.3.3.2 of the ER (Exelon 2006a). The thermal load discharged into the lake from the existing CPS unit results in localized elevated temperatures in the lake. These elevated temperatures are the most significant water quality concern associated with the existing unit. Operational impacts of a new nuclear unit on Clinton

Lake water quality are discussed in Section 5.3.3 of this EIS. Monitoring programs for thermal and chemical water quality are discussed in Sections 2.6.3.3 and 2.6.3.4, respectively.

Clinton Lake, a stream reach upstream of Clinton Lake, and several downstream reaches are on the Illinois Integrated Water Quality Report and Section 303(d) List – 2006 (IEPA 2006) as impaired for one or more of the following attributes: excess algal growth, metals, fecal coliform, dissolved oxygen, organics, and loss of habitat. The only upstream impairment was a loss of habitat with no listed source of the impairment. Fecal coliform is noted at several downstream reaches with no listed source of impairment. Excess algal growth and metals impairments were listed for Clinton Lake. The existing CPS unit has a NPDES permit from the IEPA. Before a new nuclear unit could begin to operate, Exelon would be required to obtain a NPDES permit for the discharge.

2.6.3.2 Groundwater Quality

Groundwater quality is discussed in Section 2.3.3.3 of the ER (Exelon 2006a). Groundwater samples from the Mahomet Aquifer collected in 1974 at the CPS test well were similar to groundwater samples taken by the Illinois State Water Survey in 2000 from five locations within the Mahomet Aquifer. Groundwater in the region is characterized by high levels of total dissolved solids.

2.6.3.3 Thermal Monitoring

This section describes pre-application and pre-operational thermal monitoring programs. As a result of ongoing monitoring associated with the existing CPS unit, Exelon is able to consider this existing monitoring program as part of the pre-application and pre-operational monitoring program at the ESP site. Many of these same monitoring activities would be continued if the ESP unit were completed and would become part of the operational monitoring for the ESP unit. In Section 6.1 of its ER, Exelon describes the lake temperature measurements directly associated with the current site operation that are required under the terms of its existing NPDES permit (Exelon 2006a). Clinton Lake is also part of the IEPA Bureau of Water's ambient lake program (BOW 2004). Additionally, thermal lake data is collected as part of the environmental monitoring program for Clinton Lake.

Baseline data were collected at the Rowell gauge before construction of the dam and after its completion. The Illinois State Geologic Survey has continued to monitor temperatures at the Rowell gauge downstream of Clinton Lake after the CPS Unit 1 went online. The IEPA monitors temperatures as part of its ambient lake program. Additionally, the operator of the existing CPS unit is required to sample temperatures within the discharge plume and approximately 30 m (100 ft) downstream of the dam. In addition to the existing CPS monitoring locations, Exelon proposes two new sampling locations to better understand the temperature of the inflow coming into the lake and the temperature of flow before being discharged from the dam.

2.6.3.4 Chemical Monitoring

This section describes the pre-application and operational chemical monitoring programs. As part of pre-application monitoring, the applicant will collect data in addition to that already available from monitoring required by the CPS NPDES permit.

The CPS NPDES permit establishes chemical discharge limits at a variety of locations internal to the CPS unit and at the discharge flume. Chemical monitoring of a variety of constituents is required, including pH, chloride, mercury, nitrate, suspended solids, and dissolved oxygen. Data collection for the pre-operational and operational monitoring program will include monthly or more frequent sampling of dissolved oxygen, specific conductance, and pH at two depths in Salt Creek below the Clinton Dam. The thermal monitoring program conducted for the CPS under its NPDES permit constitutes a portion of the monitoring program for Clinton Lake. The applicant will conduct additional pre-application monitoring of Clinton Lake at four locations that coincide with CPS monitoring locations and two new locations, one located upstream from farthest CPS monitoring location and the other located in Clinton Lake near the dam. The NPDES permit for the ESP unit will determine the analytical parameters to be monitored. The applicant will also implement a pre-application monitoring program for groundwater to define baseline groundwater quality conditions, using piezometer measurements at selected wells.

Construction and pre-operational monitoring will be an extension of the pre-application monitoring program until the operation of the ESP unit started to assess water quality changes that may result from construction of the ESP unit. Operational monitoring program will be an extension of the construction and pre-operational monitoring program (Exelon 2006a).

2.7 Ecology

All of the Exelon ESP site has been graded or otherwise developed for operation of the existing CPS. Consequently, most of the area proposed for construction of a new nuclear unit at the ESP 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 the area designated for the new intake structure is forested. There are four minor herbaceous wetlands (less than 0.4 ha [1 ac]) within the ESP site boundary, but none of these would be located within the footprint of a new nuclear unit. Generally, wildlife species found on the ESP site are representative of those commonly found in the central Illinois region.

Sections 2.7.1 and 2.7.2 provide general descriptions of terrestrial and aquatic environments on and near the ESP site. They provide detailed descriptions, where needed, to support the analysis of potential environmental impacts of construction, operation, and decommissioning of a new nuclear unit. The descriptions are provided to support mitigation activities identified during the assessment to avoid, reduce, minimize, rectify, or compensate for potential impacts. Descriptions are also provided to facilitate comparison of the alternatives to the ESP site. Also included are descriptions of monitoring programs for terrestrial and aquatic environments.

2.7.1 Terrestrial Ecology

The ESP site is located in the Central Cornbelt Plains ecoregion (Omernik 1987). This ecoregion consists of glaciated plains that were once dominated by extensive prairie communities intermixed with oak-hickory forests. Farms are now extensive over the ecoregion where little native prairie remains. Land use surrounding the ESP site consists primarily of a patchwork of agricultural fields and pasture.

2.7.1.1 Terrestrial Communities of the Exelon ESP Site

Vegetation

A variety of vegetation communities in various stages of ecological succession can be found near the vicinity of the ESP site (Figure 2-4) and along the transmission line rights-of-way. Agriculture (including hay, row crops, and small grains) is the predominant land use within 10 km (6 mi) 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 ESP site (Exelon 2006a).

Upland forest communities in the vicinity of the ESP 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*) (Exelon 2006a).

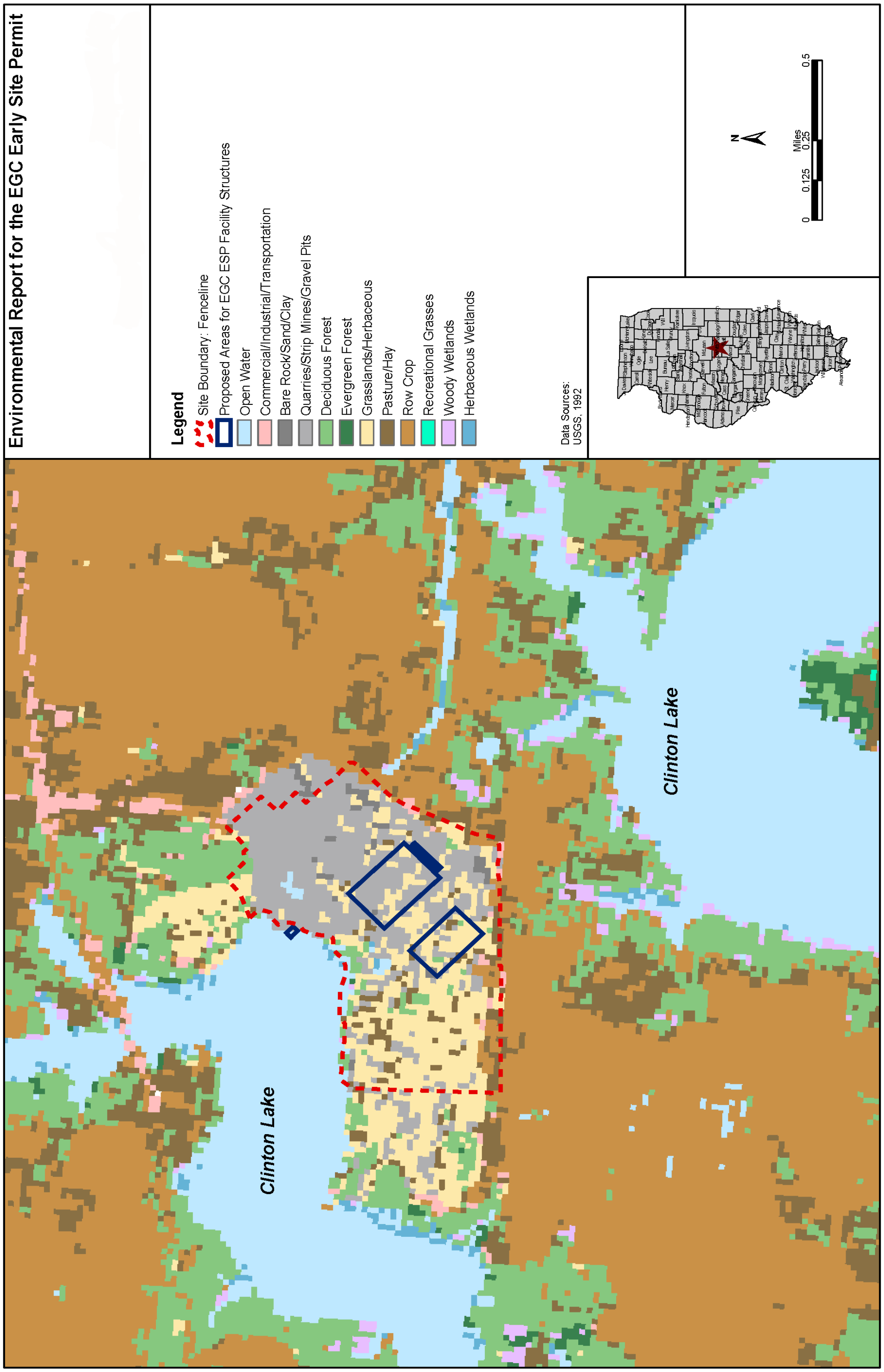

Figure 2-4. Land Use/Land Cover in the Vicinity of the Exelon ESP Site (Exelon 2006a)

Herbaceous wetlands are located within 10 km (6 mi) of the Exelon ESP site. Three 100-year floodplain areas containing forest, emergent, and scrub-shrub communities are also located within 10 km (6 mi) of the site and along the transmission line rights-of-way. These generally are associated with small tributaries of Salt Creek and the North Fork of Salt Creek. Tree species commonly found within wetland and floodplain forests include hackberry, elm, black walnut, silver maple (*Acer saccharinum*), and box elder (*Acer negundo*). Common understory species include Canadian woodnettle (*Laportea canadensis*), avens (*Geum* spp.), and beggarticks (*Bidens* spp.). Invasive perennial weeds, including purple loosestrife (*Lythrum salicaria*) and cutleaf teasel (*Dipsacus laciniatus*), are becoming increasingly more common in wet areas. Cutleaf teasel is known to occur on the ESP site near the existing facilities (Exelon 2006a).

Important terrestrial habitats in the vicinity of the ESP site include Clinton Lake State Recreation Area, Weldon Springs State Recreation Area, and wetlands recognized in the National Wetlands Inventory database. Clinton Lake is part of the Clinton Lake State Recreation Area, consisting of approximately 3764 ha (9300 ac), operated by the IDNR since 1978 via a long-term lease with 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, that are important for a variety of birds (Exelon 2006a). 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 AmerGen.

Weldon Springs State Recreation Area is a 150-ha (370-ac) park located southeast of the City of Clinton and approximately 10 km (6 mi) from the ESP site. 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 (Exelon 2006a).

According to the National Wetland Inventory database, there are four minor herbaceous wetlands (less than 0.4 ha [1 ac]) within the Exelon ESP site boundary (see Figure 2-4). These generally consist of open water in association with constructed sediment basins and have palustrine unconsolidated bottoms (Exelon 2006a).

Wildlife

Wildlife species found in the vicinity of the ESP site and along the transmission line rights-of-way are representative of those commonly found in the central Illinois region. A number of mammal species have been identified, including the 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 zibethica*), 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 (Exelon 2006a).

Habitats located in the vicinity of the ESP site and along the transmission line rights-of-way 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 (Exelon 2006a).

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 (Exelon 2006a).

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 (Exelon 2006a).

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

State-Listed Species

Location information for State-listed species within 3.2 km (2 mi) and 16 km (10 mi) of the ESP site was obtained from the IDNR (IDNR 2004a). The IDNR Natural Heritage Program also maintains current lists of State-listed threatened or endangered species at its website (IDNR 2004b).

The bald eagle (*Haliaeetus leucocephalus*) and Indiana bat (*Myotis sodalis*) (Table 2-4), both Federally listed species further described in Section 2.7.1.2, are also State-listed (IDNR 2004b) but are not known to occur within 16 km (10 mi) of the Exelon ESP site (IDNR 2004a). There are no other State-listed threatened or endangered animal species known to occur on or in the vicinity of the Exelon ESP site (IDNR 2004a). However, according to the applicant (Exelon 2006a) the local Audubon Society and other sources of birding in Illinois have reported sightings of State-listed threatened or endangered bird species in the general area. These include the snowy egret (*Egretta thula* [endangered]), Henslow's sparrow (*Ammodramus henslowii* [endangered]), northern harrier (*Circus cyaneus* [endangered]), peregrine falcon (*Falco peregrinus* [endangered]), black-crowned night heron (*Nycticorax nycticorax* [endangered]), short-eared owl (*Asio flammeus* [endangered]), sandhill crane (*Grus canadensis* [threatened]), pied-billed grebe (*Podilymbus podiceps* [threatened]), bald eagle (threatened), brown creeper (*Certhia americana* [threatened]), and red-shouldered hawk (*Buteo lineatus* [threatened]).

There are no State-listed threatened or endangered plant species known to occur within a 16-km (10-mi) radius of the ESP site (IDNR 2004a; Exelon 2006a).

2.7.1.2 Threatened or Endangered Terrestrial Species

This section describes Federally listed and proposed threatened or endangered terrestrial species and designated and proposed critical habitat that may occur in the vicinity of the Exelon ESP site and transmission line rights-of-way. The U.S. Fish and Wildlife Service (FWS) maintains current lists of Federally listed threatened or endangered species at its website (FWS 2004a). General information on the distribution and habitat use of Federally listed species in the region, including their presence or absence in DeWitt County, was obtained from the FWS (FWS 2004b). Location information for Federally listed species within 3.2 km (2 mi) and 16 km (10 mi) of the ESP site was obtained from the IDNR (IDNR 2004a).

The staff has prepared a biological assessment (Appendix F, see letter dated April 7, 2005) of the Federally listed threatened and endangered terrestrial animal species identified by the FWS as potentially occurring in the project area (Table 2-4) (FWS 2004b). Life history attributes of these species that are pertinent to the staff's review of Exelon's ESP application, as well information on the occurrence of these species in the project area, are provided in the biological assessment and in this section.

Table 2-4. Federally Listed Terrestrial Species that May Occur in the Vicinity of the Exelon ESP Site and Transmission Line Rights-of-Way

Scientific Name	Common Name	Status[(a)]	Source
Haliaeetus leucocephalus	bald eagle	FT/ST	FWS 2004a, IDNR 2004a
Myotis sodalis	Indiana bat	FE/SE	FWS 2004a, IDNR 2004a

(a) Federal status rankings developed by the U.S. Fish and Wildlife Service under the Endangered Species Act, FE = Federal endangered, FT = Federal threatened. State status rankings are SE = state endangered, ST = state threatened.

There are two Federally listed terrestrial animal species, the threatened bald eagle and the endangered Indiana bat, which may occur in the vicinity of the ESP site and transmission line rights-of-way (FWS 2004b). There are no Federally proposed threatened or endangered animal species or designated or proposed critical habitat known to occur on or in the general area of the ESP site (IDNR 2004a; Exelon 2006a; FWS 2004b).

Bald Eagle - Threatened

The bald eagle is known to winter along large rivers, lakes, and reservoirs in DeWitt County (FWS 2004b) and has been observed in the general area of the ESP site (Exelon 2006a), although there are no documented records of its occurrence within 16 km (10 mi) of the site (IDNR 2004a). During the winter, this species feeds on fish in open water areas created by dam tailwaters, by warm water effluents of power plants and municipal and industrial discharges, or by power plant cooling ponds. The more severe the winter, the greater the ice coverage and the more concentrated the eagles become. Bald eagles roost at night in groups in large trees adjacent to associated bodies of water in areas that are protected from harsh winter weather. During the day, they perch in large shoreline trees to rest or feed on fish. There is no critical habitat designated for this species (FWS 2004b).

Indiana Bat - Endangered

The Indiana bat potentially occurs throughout Illinois (FWS 2004b) and, thus, may occur on or in the vicinity of the ESP site. However, there are no records of its occurrence within 16 km (10 mi) of the site (IDNR 2004a). Critical habitat has been designated for this species (FWS 2004b); however, the only critical habitat in Illinois is the Blackball Mine in LaSalle County (41 FR 41914).

During the summer, the Indiana bat frequents the corridors of small streams with well-developed riparian woods as well as mature upland forests. It forages for insects along stream corridors, within the canopy of floodplains and upland forests, over clearings with early successional vegetation (old fields), along the borders of croplands, along wooded fencerows, over farm ponds, and in pastures. The foraging range for the species may be as large as 33 ha (81 ac) and varies by season, age, and sex. It roosts and rears its young beneath the loose bark of large dead or dying trees, and the species tends to be philopatric, i.e., returning to the same roosting area year after year. Indiana bats winter in caves and abandoned mines (FWS 2004b).

Suitable summer habitat in Illinois is considered to have the following characteristics within a 0.8-km (0.5-mi) radius of any project site

- Forest cover of 15 percent or greater
- Permanent water
- One or more of the following tree species: shagbark and shellbark hickory that may be dead or alive, dead bitternut hickory (*Carya cordiformis*), American elm (*Ulmus americana*), slippery elm (*U. rubra*), eastern cottonwood (*Populus deltoides*), silver maple, white oak (*Quercus alba*), red oak (*Q. rubra*), post oak (*Q. stellata*), and shingle oak (*Q. imbricaria*) with slabs or plates of loose bark
- At least one potential roost tree per 1 ha (2.5 ac)
- Potential roost trees with greater than 10 percent coverage of loose bark (FWS 2004b).

Federally Listed or Proposed Plants

There are no Federally listed or proposed threatened or endangered plant species, or associated designated or proposed critical habitat, known to occur on or in the vicinity of the ESP site and transmission line rights-of-way (IDNR 2004a; Exelon 2006a; FWS 2004b).

2.7.1.3 Terrestrial Ecology Monitoring

As stated in NUREG-1555, *Environmental Standard Review Plan* (ESRP) (NRC 2000), terrestrial ecological monitoring programs should cover ecosystem elements for which a causal relationship between facility construction and/or operation and adverse change is established or strongly expected. An initial baseline assessment and subsequent monitoring of generic wildlife and vegetation communities were conducted in the vicinity of the ESP site for CPS (Exelon 2006a). These studies were designed to provide data on naturally occurring year-to-year variations during preconstruction, construction, and post-construction phases of the project (Exelon 2006a).

The applicant has stated that it will conduct a similar generic wildlife and vegetation monitoring program for the ESP unit and along the transmission line rights-of-way, as appropriate, e.g., in forested areas (Exelon 2006a). The monitoring program will document changes in plant and animal species composition, abundance, and distribution over time, in order to confirm that changes are not occurring as a result of the ESP unit (Exelon 2006a). The elements and timing of this monitoring program are described in this EIS, because site preparation and limited construction activities may be conducted under the ESP, e.g., clearing, grading, and construction of non-safety-related facilities (Exelon 2006d). The elements and timing of this monitoring program are currently anticipated to be similar to those undertaken previously for CPS and are described below. These may be modified and further defined prior to or during the CP or COL phase and would be presented in future environmental documentation.

Five vegetation communities will be inventoried annually in May of each year, using quadrant, quarter, and transect sampling techniques (Exelon 2006a). Waterfowl surveys at Clinton Lake and other water bodies in the near vicinity will be performed during migration and nesting, in May, July, November, and February of each year (Exelon 2006a). In addition, the results of avian surveys performed by local groups, including the Audubon Society, will be reviewed. Small mammal populations will be surveyed at five locations in the vicinity, via trapping and recording of sightings and sign (Exelon 2006a). Monitoring of important species (e.g., Federal and State listed species) and habitats (e.g., wetlands, floodplains, State natural areas), as defined in NUREG-1555 (NRC 2000), either on or in the vicinity the ESP site, is currently not anticipated for the ESP unit (Exelon 2006a).

2.7.2 Aquatic Ecology

This section describes the aquatic ecological resources existing at and within the vicinity of the ESP site. This description focuses on the habitats and species that could be affected by the construction or operation of a new nuclear unit at the ESP site.

2.7.2.1 Aquatic Communities of the Exelon ESP Site

Clinton Lake is the largest and most important aquatic resource in the vicinity of the ESP site. The 1981-ha (4895-ac) 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 13 m [40 ft]), but the average water depth is approximately 5 m (15 ft). The ESP site is located approximately 5 km (3 mi) northeast of the dam between the North Fork of Salt Creek and Salt Creek arms of the lake. The lake is the main attraction for the Clinton Lake State Recreation Area, a 3764-ha (9300-ac) facility located 5 km (3 mi) east of Clinton, Illinois. The park land is owned by 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 (IDNR 2003b). People use the park's lake, marsh, and riverine habitats for boating, swimming, and recreational fishing.

Besides the lake, other important aquatic habitats near the ESP 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 ESP site. The first includes a portion of Tenmile Creek west of the City of Clinton and approximately 8 km (5 mi) 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 (Exelon 2006a). The second environmentally sensitive area is along Salt Creek, approximately 5 km (3 mi) from the ESP site. Weldon Springs State Recreation Area is located southeast of the City of Clinton, approximately 10 km (6 mi) from the proposed ESP site. The area includes a 11-ha (28-ac) 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 10 km (6 mi) of the ESP site and along the proposed transmission line rights-of-way. These wetland areas include forested, shrub-scrub, and emergent vegetation communities. Additionally, four small wetland areas, each less than 0.4 ha (1 ac), are present on the site. These are open water resources, such as constructed sediment basins (Exelon 2006a), some of which are used by IDNR as fish-rearing ponds.

There are no Federally or State-listed fish species found in DeWitt County (FWS 2003a, 2003b; IDNR 1999; Illinois Natural History Survey (INHS) 2004; see Section 2.7.2.2). There are also no commercial fisheries in the vicinity of the ESP site (Exelon 2006a). 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, as defined in NUREG-1555 (NRC 2000). These include such species as the channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), bullhead (*Ameiurus* spp.), white bass (*Morone chrysops*), striped bass (*Morone saxatilis*), 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.) (City of Clinton 2006; IDNR 2003b). Tiger muskellunge (an artificial cross between muskellunge [*Esox masquinongy*] and northern pike [*Esox lucius*]), sauger (*Sander canadensis*), and common carp (*Cyprinus carpio*) are also present, and sometimes caught by sport fishermen (IDNR 2003c). While much of the fishing activity occurs during the warmer months, ice fishing also attracts people to Clinton Lake in winter (IDNR 2003b).

Some recreational fish species are stocked by the IDNR to provide improved fishing opportunities for the public. In 2004, these were expected to include hybrid striped bass, striped bass, smallmouth bass, walleye, and white crappie (IDNR 2003c). 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 (IDNR 1999b). 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.

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 2003b). 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 (IDNR 2006a).

Besides the sport fish, many other fish species common to Illinois lakes and reservoirs are present in Clinton Lake. The Clinton Lake fish community is dominated by gizzard shad (*Dorosoma cepedianum*), common carp, quillback (*Carpoides cyprinus*), and bigmouth buffalo (*Ictiobus cyprinellus*). Several shiner species, creek chub (*Semotilus atromaculatus*), and white sucker (*Catostomus commersoni*) are also present.

There is currently a statewide methyl-mercury advisory for pregnant women, nursing women, women of child-bearing age, and children under 15 years of age. These more sensitive populations are advised to consume no more than one meal per week of predator fish, including some species that occur in Clinton Lake: sauger, walleye, all bass species, and flathead catfish (IDNR 2006).

The section of Salt Creek between Clinton Lake and Kickapoo Creek (Figure 2-5) was cited in 2001 as supporting endangered mussel species and as having high mussel diversity (i.e., more than ten live species or with a Shannon-Weaver Diversity index greater than 2.5), according to data collected post-1976 (IPCB 2001).

There are currently no known nuisance aquatic species in Clinton Lake. However, at least one of four species of exotic Asian carp (i.e., bighead carp [*Hypophthalmichthys nobilis*], black carp [*Mylopharyngodon piceus*], grass carp [*Ctenopharyngodon idella*], or silver carp [*Hypophthalmichthys molitrix*]) has been confirmed by IDNR as present in Salt Creek downstream of the Clinton Lake Dam. The concern from an ecological perspective is that these species, originally imported for use in the aquaculture industry, may become as widely distributed and abundant as the common carp, potentially outcompeting native fish and shellfish for habitat and food (FWS 2004c). To date, another aquatic nuisance species of concern in the region, the zebra mussel (*Dreissena polymorpha*), has not been identified in Clinton Lake (IDNR 2006a). These mussels may unwittingly be transported to new water bodies by boaters and can harm native aquatic species through competition for such food items as phytoplankton and zooplankton. Should the Asian carp or zebra mussel invade Clinton Lake, the current balance of species in the lake ecosystem could be disrupted.

State-Listed Species

The IDNR endangered and threatened species list is revised every 5 years by the Illinois Endangered Species Protection Board. The current list was generated in 2004 (IDNR 2004b). Eighteen fish are State-listed as endangered; eight as threatened. None of the State-listed species found in the INHS fish collection was collected from DeWitt County (INHS 2003a).

Twenty mussel species were State-listed as endangered; seven as threatened. However, only two of the mussels, both threatened, are included on the INHS list, "Mussels of DeWitt County" (INHS 2003b): the slippershell mussel (*Alasmidonta viridis*) and the spike (*Elliptio dilatata*).

The slippershell mussel inhabits creeks and the headwaters of large rivers in sand, mud, or fine gravel (Table 2-5). A map of Midwest mussel habitats indicates that the slippershell mussel may be present in DeWitt County and the surrounding region (Cummings and Mayer 1992). The spike inhabits small to large streams and, occasionally, lakes in mud or gravel. It is widespread, but sporadic, in distribution. The INHS range map for this species indicates the spike may be present in DeWitt County and the surrounding region (Cummings and Mayer 1992). Exelon queried the 2002 IDNR GIS database and found documented occurrences of the spike 16 km (10 mi) from the ESP site. There were no documented occurrences of the spike in Clinton Lake, or any other watercourses within a 10-km (6-mi) radius of the site (Exelon 2006a). Database queries for each of the State-listed plant species (263 endangered; 75 threatened) were made of the extensive INHS vascular plant collection (INHS 2003a). No State-listed aquatic plants were found in the INHS database for DeWitt County. The results of the staff's review of the IDNR species list, INHS database, and Exelon's ER indicate that no State-listed threatened or endangered aquatic plant species are known to occur on or in the vicinity of the ESP site (IDNR 2004b; Exelon 2006a).

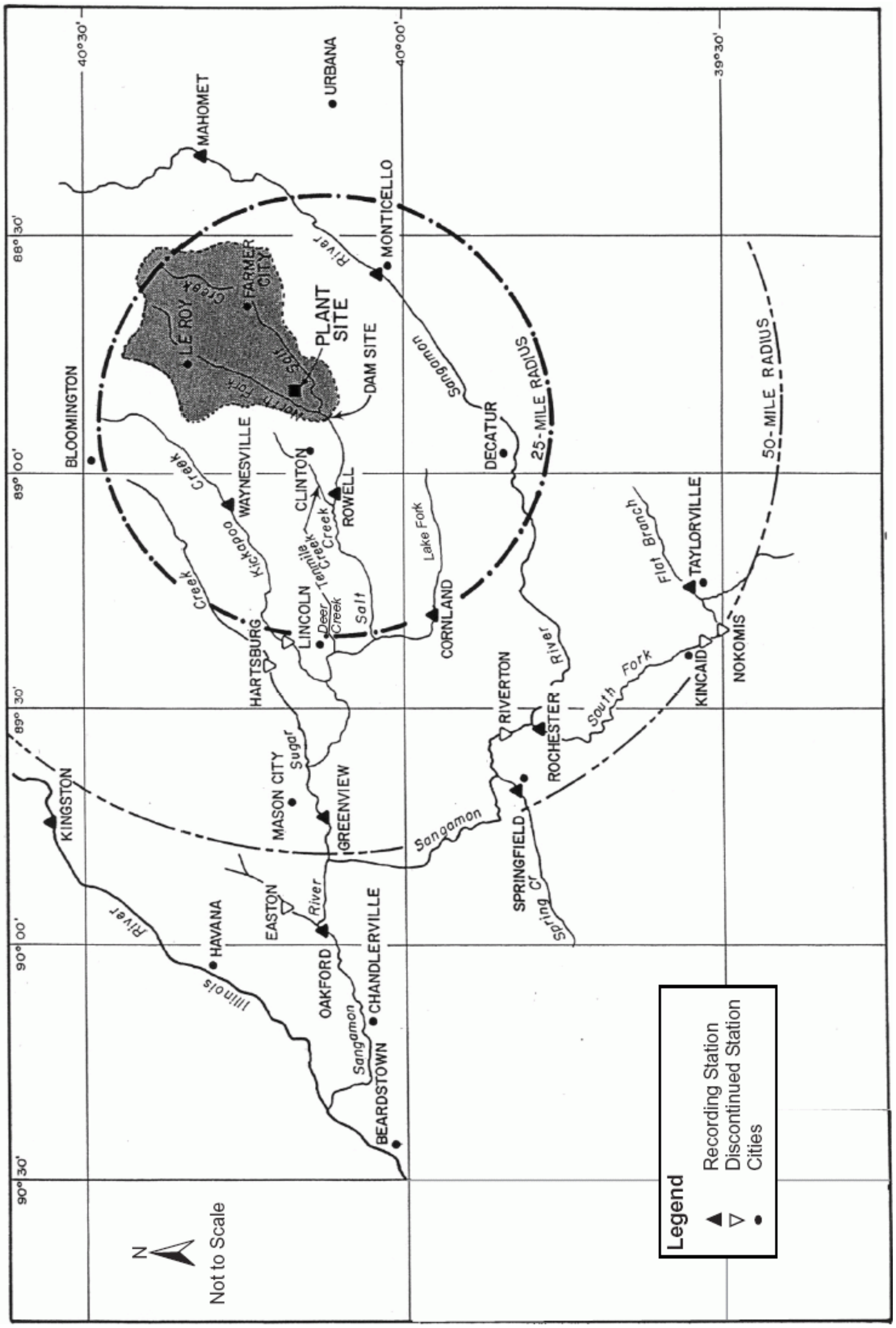

Figure 2-5. Sangamon River Basin (Exelon 2006a)

Table 2-5. State-Listed Aquatic Species in Illinois That May Be Present in the Vicinity of the Exelon ESP Site

Scientific Name	Common Name	Status	Comments
Alasmidonta viridis	Slippershell mussel	Threatened	Mussel
Elliptio dilatata	Spike	Threatened	Mussel

2.7.2.2 Threatened or Endangered Aquatic Species

This section describes Federally listed threatened, endangered, and proposed aquatic species and designated and proposed critical habitats known to occur on or in the vicinity of the ESP site.

A review of the FWS database of county distributions of Federally listed species in Illinois indicated that 15 aquatic animal species are listed as threatened or endangered (FWS 2006). However, none is known to be present in DeWitt County or in any of the counties surrounding the ESP site (i.e., Logan, Macon, McLean, or Piatt Counties). The FWS database also indicated that no Federally listed or proposed aquatic plant species or critical habitat are known to be present in DeWitt County or in any of the counties surrounding the ESP site (i.e., Logan, Macon, McLean, or Piatt Counties) (Exelon 2006a; FWS 2003a). For confirmation, the staff requested a list of endangered, threatened, candidate, and proposed species, and designated and proposed critical habitat that might be in the vicinity of the CPS site and its transmission line rights-of-way along with any other information considered appropriate under the provisions of the Fish and Wildlife Coordination Act of 1934 (NRC 2004b). In its response, the FWS indicated that there were no known occurrences of aquatic species or critical habitat in DeWitt or McLean Counties (FWS 2004b).

2.7.2.3 Aquatic Ecology Monitoring

As stated in NUREG-1555 (NRC 2000), aquatic ecological monitoring programs should cover ecosystem elements for which a causal relationship between facility construction and/or operation and adverse change is established or strongly expected. An initial baseline assessment and subsequent monitoring efforts have already been conducted at the ESP site under the Illinois Power Company and Exelon environmental monitoring programs (Exelon 2006a; IPC 1973, 1982). In these studies, aquatic ecology data were gathered to characterize the ecology of the site before and during construction of the CPS and following CPS operation. Data gathered during pre-construction and construction periods included information on water quality, the periphytic algal community, benthic macroinvertebrates (organisms that live on or in the lake substrate), and fish. In general, two effects were noted due to lake and CPS construction activities. There was a temporary increase in turbidity and nonfilterable residue downstream from the Clinton Lake Dam construction site and changes to the algal community resulting from the shift from a variable stream flow prior to dam closure to a stable stream flow after dam closure (IPC 1982). Benthic macroinvertebrate and fish species composition changed somewhat, but the overall abundance and species variety seemed unaffected by construction (IPC 1982).

Post-operational effluent and aquatic ecology monitoring at CPS has been conducted under the direction of the IEPA, through the NPDES permit (effective permit IL0046919). This is the agency delegated by the U.S. EPA to be responsible for regulation of aquatic issues under the Clean Water Act that involve water quality and aquatic biota. For example, fish impingement studies were conducted over a 1-year period after operation of CPS Unit 1 commenced, as required by the CPS NPDES permit in effect at that time (Pallo 1988). The research indicated that more than 99 percent of fish impinged were young-of-the-year gizzard shad, a prolific forage fish species that typically experiences a naturally high young-of-the-year mortality rate and commonly demonstrates mass mortality in winter when water temperatures approach 4°C (39°F).

Under the current NPDES permit, discharge to Clinton Lake must meet specific requirements for flow, pH, total residual chlorine, total residual oxidants, and temperature (IEPA 2000). There are also temperature requirements associated with water discharged from the Clinton Lake Dam to Salt Creek (IPCB 1993). There is currently no specific aquatic ecological monitoring of the algal community, benthic invertebrates, or fish required by this NPDES permit or by the NRC under the CPS Unit 1 Environmental Protection Plan (nonradiological), other than reporting any occurrence of an unusual or important event causally related to plant operation that could result in significant environmental impact (IPC 1987). However, since 1978, the Clinton Lake State Recreation Area, which consists of approximately 3764 ha (9300 ac) including Clinton Lake, has been operated by IDNR through a long-term lease agreement with the owners of CPS (Exelon 2006a). The IDNR conducts its own surveys of aquatic biota primarily to ensure conservation and enhancement of the fishery resource while providing fishing opportunities to the public. In addition to netting, seining, and electroshocking to sample fish species composition, relative abundance, condition, and size distributions, the IDNR Division of Fisheries conducts a number of creel surveys on different lakes and rivers each year to determine the relative success of fisheries management activities and fish stocking efforts (IDNR 2003a). The IDNR also attempts to prevent the introduction and spread of aquatic nuisance species in Illinois waters and tracks the presence of these nuisance species.

Elements of the monitoring program for the ESP site are described below. Data collected under this program would be similar to those collected during monitoring activities in support of construction and operation of the CPS. The purpose of such data is to establish species composition and abundance and characterize naturally occurring annual variation within the communities, so that changes in these communities due to construction or operation of the ESP facility can be detected (Exelon 2006a). The hydrological, thermal, and chemical monitoring outlined in Section 2.6 of this EIS will also contribute significantly to the overall understanding of how aquatic species and habitats may be affected by construction and operation of a new nuclear unit at the site.

Site preparation and construction monitoring, pre-operational monitoring, and operational monitoring programs would be provided at the CP or COL phase, in accordance with the schedule provided in NUREG-1555 (NRC 2000). Exelon expects that monitoring would be required by the IEPA (e.g., impingement) and performed in conjunction with construction and operation of a new nuclear unit at the ESP site.

Exelon proposes to reinstate a fisheries monitoring program based on the one established in support of the 1973 CPS ER for the CP stage (IPC 1973). Recommendations for improving on this monitoring program were made by the Illinois Power Company in the 1982 ER for CPS for the operating license stage (IPC 1982), and the NRC intends to revisit these at the CP or COL phase. Because the IDNR currently implements routine fish sampling programs in the vicinity of the proposed ESP facility, Exelon will coordinate with IDNR so that the program will adequately monitor fishery resources and Exelon does not duplicate any IDNR data collection and sampling efforts (Exelon 2006a).

Exelon has not conducted surveys for Federally listed aquatic threatened or endangered or proposed species or of designated or proposed critical habitats, because none is known to occur in the vicinity of the ESP site (Exelon 2006a). Similarly, there will be no monitoring of State-listed aquatic threatened or endangered species because none is known to occur within 10 km (6 mi) of the ESP site.

The requirement for additional pre-application aquatic monitoring would be at the discretion of the IEPA. Monitoring of the aquatic ecology during CPS pre-construction and construction phases involved sampling periphyton, benthic macroinvertebrates, and zooplankton. Exelon has not committed to monitoring any of these aquatic ecological resources, unless directed to do so by the IEPA, as these species are not of commercial or recreational importance and are not expected to be adversely affected by construction or operation of a new nuclear unit at the ESP site (Exelon 2006a).

2.8 Socioeconomics

This section presents the socioeconomic resources that could be potentially impacted by the construction, operation, and decommissioning of a new nuclear unit. The section contains two subsections: (1) demography and (2) community characteristics. These subsections include discussions on spatial (e.g., regional, vicinity, and site) and temporal (e.g., 10-year increments of population growth) considerations, where appropriate, as referenced. The area of interest for the socioeconomic analysis that follows is the Counties of Champaign, DeWitt, Logan, Piatt, Macon, and McLean.

2.8.1 Demographics

The resident population distribution around the ESP site out to an 80-km (50-mi) radius is based on the 2000 Census. Table 2-6 presents the population in the concentric rings starting from 0 to 16 km (0 to 10 mi), 16 km to 40 km (10 to 25 mi), 40 km to 60 km (25 to 37 mi), and 60 km to 80 km (37 to 50 mi), and projected population increases in those rings from 2000 to 2060 in 10-year increments. Population projections for 2010 and 2020 are based on a methodology developed by Illinois State University (Exelon 2006a). They are based on 1990 populations and fertility, mortality, and migration rates from the early 1990s. The data have not been adjusted for the more recent 2000 Census population. The State of Illinois is preparing population projections based on the 2000 Census, but these are not expected to be released until 2004 to 2006 (Exelon 2006a). A ratio of the population in 2010 and 2020 was used to determine the projected population for the years 2030, 2040, 2050, and 2060. The population annual growth percentage ranges between 0.44 percent (for years 2000 to 2010) and 0.31 percent (for years 2050 to 2060). Total growth in population between 2000 and 2060 is projected at 23 percent.

All or parts of 20 counties and four major cities (Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield) are located within 80 km (50 mi) of the ESP site and are principal economic centers in the region. Decatur (population 81,860), due south of the ESP site, and

Table 2-6. Resident Population Distribution from 2000 to 2060 Within 80 km (50 mi) of the Exelon ESP Site

Year	0 to 16 km (0 to 10 mi)	16 to 40 km (10 to 25 mi)	40 to 60 km (25 to 37 mi)	60 to 80 km (37 to 50 mi)	Total	Annual Growth Percent
2000	12,358	222,424	267,376	262,208	764,366	-
2010*	11,767	229,680	283,901	272,986	798,334	0.44
2020*	11,506	237,333	296,856	281,481	827,176	0.35
2030*	11,244	244,987	309,812	289,978	856,021	0.34
2040*	10,983	252,640	322,764	298,476	884,863	0.33
2050*	10,727	260,289	335,723	306,972	913,711	0.32
2060*	10,462	267,946	348,680	315,468	942,556	0.31

*Estimated population. Source: Exelon 2006a

Bloomington-Normal (population 110,194), due north of the site, lie within 16 to 40 km (10 to 25 mi) (USCB 2000a). Champaign-Urbana (population 103,913), due east of the ESP site, lies within 60 to 80 km (37 to 50 mi) (USCB 2000a). Springfield (the State capitol, population 114,454), southwest of the ESP site, straddles the 80-km (50-mi) radius and is also a principal economic center (USCB 2000a). Other smaller communities within 80 km (50 mi) include Lincoln (population 15,369), due west of the ESP site and within the 40- to-60-km (25-to-37-mi) radius; Monticello (population 5138), southeast of the site and within the 60- to-80-km (37-to-50-mi) radius; and Taylorville (population 11,427), southwest of the site and along the 80-km (50-mi) radius (USCB 2000a). The largest population center within the 16-km (10-mi) area is the City of Clinton (population 7485), due west of the ESP site (USCB 2000a).

Table 2-7 lists the age distribution in DeWitt, Logan, Macon, McLean, Champaign, and Piatt Counties in 2000 and compares it to the age distribution in the State of Illinois. The counties' age-distributed populations closely track within approximately 4 percent of each other. The exceptions are McLean and Champaign Counties, which for the 18 to 24 age range are at 19 and 23 percent, respectively, of the total population, versus the other counties, which range between 7 and 11 percent, and Illinois at 10 percent. The reason for the difference with the other counties is the presence of the University of Illinois at Champaign-Urbana (enrollment at 38,872 during Fall 2003 [University of Illinois 2003]) and Illinois State University (enrollment at 20,705 during Fall 2003 [ISU 2003]) at Bloomington-Normal. In the 65-and-over age group, McLean and Champaign Counties are at 10 percent, versus the other counties which range between 15 and 16 percent and Illinois at 12 percent. McLean and Champaign Counties are also somewhat lower than the other counties for the 45-to-64 age group at 18 and 19 percent, respectively, versus 22 to 25 percent for the remaining counties and 21 percent for Illinois.

Table 2-8 contains data on population, projected population, and annual growth rates for the area of potential impact (Champaign, DeWitt, Logan, McLean, Piatt, and Macon Counties) from

Table 2-7. Estimated Age Distribution of Population in 2000 for Counties and State of Illinois

	Champaign County		DeWitt County		Logan County		Macon County		McLean County		Piatt County		State of Illinois	
Age Group	**Popu-lation**	**%**	**Popu-lation**	**%**	**Popu-lation**	**%**	**Popu-lation**	**%**	**Popu-lation**	**%**	**Popu-lation**	**%**	**Popu-lation**	**%**
Under 18	37,819	21	4126	25	6824	22	28,171	25	35,292	23	4115	25	3,245,451	26
18 to 24	41,432	23	1302	8	3617	11	11,214	10	28,000	19	1117	7	1,210,898	10
25 to 44	50,603	28	4760	28	9249	30	30,312	26	43,896	29	4518	28	3,795,544	31
45 to 64	32,345	18	3944	23	6802	22	27,528	24	28,624	19	4086	25	2,667,375	21
65 and over	17,470	10	2666	16	4691	15	17,481	15	14,621	10	2529	15	1,500,025	12
Totals	179,669		16,798	100	31,183	100	114,706	100	150,433	100	16,365	100	12,419,293	100

Source: USCB 2000b

Table 2-8. Population Growth in Champaign, DeWitt, Logan, McLean, Macon, and Piatt Counties, 1970 to 2020[(a)]

	Champaign		DeWitt		Logan		McLean		Macon		Piatt	
Year	Popu-lation	Annual Growth Percent	Popu-lation	Annual Growth Percent	Popu-lation	Annual Growth Percent	Popu-lation	Annual Growth Percent	Popu-lation	Annual Growth Percent	Popu-lation	Annual Growth Percent
1970	163,281		16,975		33,538		104,389		125,010		15,509	
1980	168,392	0.3	18,108	0.6	31,802	-0.5	119,149	1.3	131,375	0.5	16,581	0.7
1990	173,025	0.3	16,516	-0.9	30,798	-0.3	129,180	0.8	117,206	-1.1	15,548	-0.6
2000	179,669	0.4	16,798	0.2	31,183	0.1	150,433	1.5	114,706	-0.2	16,365	0.5
2010	194,953	0.8	16,018	-0.5	33,449	0.7	156,685	0.4	117,906	0.3	16,636	0.2
2020	206,417	0.6	15,635	-0.2	33,965	0.2	165,592	0.6	118,505	0.1	17,270	0.4

Sources: USCB (for 1970 to 1990) 2000h and IDOCEO 2004
(a) Projected population for 2010 and 2020; values for 1970 through 2000 are actual census population numbers.

1970 through 2020. The fastest growing counties in the region over the 50-year period, including projected populations between 2000 and 2020, are McLean and Champaign Counties.

During the 1990s, McLean County grew at an annual rate of 1.5 percent while Champaign County grew at annual rate of 0.4 percent. DeWitt County, the county most impacted economically by CPS, actually lost population during the 1980s and gained a small amount of population during the 1990s. DeWitt County is projected to lose population between 2000 and 2020. Logan, Macon, and Piatt Counties also lost population during the 1990s.

2.8.1.1 Transient Population

The area within the first 16 km (10 mi) of the ESP site is predominately rural and characterized by farmland, which accounts for 82 percent or 24,229 ha (59,870 ac) of the total land area. Industrial land use within the vicinity is less than 1 percent and is limited to areas near Clinton and Weldon. Less that 1 percent of the land within the site vicinity is residential and consists primarily of residential areas near Clinton and Weldon. The land use was confirmed by Exelon with a review of recent aerial photographs taken by the U.S. Geological Survey (Exelon 2006a).

There are approximately 130 small businesses located within the 16-km (10-mi) radius of the ESP site. Exelon considered employees of businesses within the radius as transients and not living within the 16-km (10-mi) radius. Other populations considered transients include the hotel/motel population; special populations such as schools, hospitals, nursing homes, and correctional facilities; and visitors at the annual Apple and Pork Festival, held in Clinton (Exelon 2006a).

2.8.1.2 Migrant Labor

Agribusiness is a major industry in the area surrounding the ESP site. In 2002, DeWitt County had 459 individual farms, Macon County 646, Logan County 692, Piatt County 442, Champaign County 1285, and McLean County had 1442 (USDA 2000). In 2001, approximately 6554 farm workers worked in the six-county area (BEA 2001). Migrant workers are typically members of minority or low-income populations. Because migrant workers travel and can temporarily spend a significant amount of time in an area without being actual residents, they may be unavailable for inclusion in the census. If this occurs, migrant workers would be under-represented in the census minority and low-income population counts. Based on average statewide statistical data provided by the Illinois Agricultural Statistics Service, 14 percent of the agricultural workforce in the six-county area, or 918 workers, is estimated to be migrant labor. These migrant laborers were considered transients by Exelon (Exelon 2006a).

Table 2-9 presents estimates of the projected transient population distribution from 2000 to 2060 within 80 km (50 mi) of the ESP site. The methods employed in projecting the population estimates for Table 2-6 are also employed for Table 2-9. The estimated annual percentage growth rate for the transient population ranged between 0.21 (2010) and 0.35 (2030).

2.8.2 Community Characteristics

A number of areas are used to define community characteristics. This section addresses the following: (1) local economy around the ESP site, (2) property taxes in the area, (3) transportation in the region, (4) the aesthetics and recreational activities near the ESP site, (5) housing in the area, (6) public services available, and (7) education in the region.

Table 2-9. Transient Population Distribution from 2000 to 2060 Within 80 km (50 mi) of the Exelon ESP Site

Year	0 to 16 km (0 to 10 mi)	16 to 40 km (10 to 25 mi)	40 to 60 km (25 to 37 mi)	60 to 80 km (37 to 50 mi)	Total	% Annual Growth
2000	11,834	7354	8677	48,029	75,894	–
2010*	11,542	7616	9100	49,242	77,500	0.21
2020*	11,213	7965	9399	51,616	80,193	0.34
2030*	11,086	8315	9698	53,981	83,080	0.35
2040*	10,946	8666	9996	56,357	85,965	0.34
2050*	10,817	9015	10,295	58,721	88,848	0.33
2060*	10,595	9365	10,594	61,097	91,651	0.31

*Estimated Population.
Source: Exelon 2006a

2.8.2.1 Economy

The principal economic centers within 80 km (50 mi) of the proposed ESP site are the Cities of Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield. In addition, East Peoria, Lincoln, Monticello, Morton, Pekin, Pontiac, Rantoul, Taylorville, and Washington are smaller communities within the 80-km (50-mi) radius. These communities collectively support the agricultural industry throughout the region. Other types of industries and major employers include manufacturing, transportation, public utilities, government, retail trade, medical services, and education (including institutions of higher education).

Table 2-10 presents the top employers for the major urban centers and counties located predominately within the 80-km (50-mi) radius of the ESP site (Champaign, DeWitt, Logan, Macon, McLean, and Piatt Counties). DeWitt County is the major beneficiary of the current CPS tax base and has the greatest number of current CPS employees living in the county, approximately 33 percent of the existing workforce. Macon and McLean Counties have approximately 24 and 21 percent, respectively, of the CPS workforce residing in the counties. Piatt County, which is adjacent to DeWitt County and contains the City of Monticello, is home to 4.5 percent of the CPS workforce. Champaign County is the home of approximately 10 percent of the CPS workforce and approximately 2 percent live in Logan County (Exelon 2004a).

The economic impacts of the existing nuclear facility at CPS are less noticeable in Macon and McLean Counties, and the economic benefits of plant operation on these larger counties are dispersed over a larger economic base. The main economic benefit to these counties is the tax benefits derived from having CPS employees, who are well paid, living in the counties, and paying sales and use taxes on purchases made in those counties, and property taxes on owned residences. Piatt and Logan Counties, which have 4.5 and 2 percent, respectively, of the existing CPS workforce residing within their boundaries, but none of the property tax benefits of the CPS plant, also receive some of the sales and use and property tax benefits of the CPS workforce.

The two largest cities in the region of interest (counties within or almost wholly within the 80-km [50-mi] radius of the ESP site) are Champaign-Urbana and Bloomington-Normal, approximately a 2-hour drive south of Chicago. Both cities are major centers of economic activity in the region. The largest employer in Champaign-Urbana is the University of Illinois, with 20,571 employees, while State Farm Insurance is the largest employer in Bloomington–Normal at 14,132 employees (IDOCEO 2004, 2005).

Table 2-10. Major Employers by City

Employer	Product	Number of Employees
Champaign-Urbana, Champaign County		
University of Illinois at Champaign-Urbana	Higher education	20,571
Carle Clinic Association	Health care	2918
Carle Foundation Hospital	Health care	2100
Champaign Community Unit School District #4	Public education	1305
Kraft Foods, Inc.	Food processing	1300
Parkland College	Higher education	1200
Clinton, DeWitt County		
AmerGen	Power generation	550
Wallace Computer Services	Printed forms	240
Action Technology	Plastic extrusion	94
McElroy Metal Mill, Inc.	Metal buildings	75
Miller Container	Corrugated cartons	60
National Environmental	Medical waste	35
Lincoln, Logan County		
Logan & Lincoln Correctional Centers	Corrections	750
Eaton Cutler Hammer	Circuit breakers	680
Abraham Lincoln Memorial Hospital	Health services	289
Precision Products	Lawn and garden equipment	236
Saint – Gobain Containers	Glass containers	209
Decatur, Macon County		
Archer Daniels Midland	Corn and soybean processing	3500
Decatur Memorial Hospital	Health care	2266
Caterpillar	Mining and construction vehicles	2000
Decatur Public School District	Education	1500
St. Mary's Hospital	Health care	1058
Tate and Lyle/A. E. Scaley	Corn processing	720
Bloomington-Normal, McLean County		
State Farm Insurance Companies	Insurance	14,132
Illinois State University	Higher education	3211
Country Insurance and Investment	Insurance and finance	2289
Mitsubishi Motor Manufacturing	Automobile	1979
BroMenn Health Care	Health care	1950
Unit 5 Schools	Education	1487
Monticello, Piatt County		
Monticello Schools – Unit #25	Education	174
Piatt County Nursing Home	Health care	150
City of Monticello	Government	150
Kirby Hospital	Health care	105
Neighborcare	Pharmaceutical	87
County of Piatt	Government	70

Sources: BNM 2003; EDCDM 2003; IDOCEO 2003, 2004, 2005; Exelon 2006b

Table 2-11 shows the unemployment rate for November 2003, the percent of individuals below the poverty line for 2000, and the median household income for 2000 for the six counties and the State of Illinois. McLean County has the lowest unemployment (2.6 percent) and the highest median household income ($47,021). Champaign County has the next lowest unemployment (3.1 percent), the highest percentage of individuals below poverty (16.1 percent), and the lowest median household income ($37,780). DeWitt County (home to CPS) had 7.4 percent unemployment rate, 8.2 percent of its individuals below the poverty line, and a median household income at $41,256. This compares to the State of Illinois unemployment rate of 6.3 percent, individuals below poverty at 10.7 percent, and median household income of $46,590.

Regional employment trends are shown in Table 2-12 for the years 1990 and 2000. McLean County grew the fastest in employment during the decade at 35.7 percent. Macon and Champaign Counties were next at 10.4 and 9.0 percent, respectively. Most of the counties showed a favorable drop in unemployment over the decade: Champaign County dropped from 4.2 percent (1990) to 3.6 percent (2000); Piatt County dropped from 4.4 percent to 3.7 percent; and Macon County increased from 4.0 percent to 5.2 percent. This compares to November 2003 unemployment estimates (Table 2-11), when Champaign, Piatt, and McLean Counties had unemployment rates of 3.1, 5.2, and 2.6 percent, respectively. DeWitt County's unemployment declined between 1990 and 2000, from 6.6 to 5.5 percent.

Table 2-11. Percent Unemployment, Individual Poverty, and Median Household Income

	Unemployment (Percent November 2003)	Individuals Below Poverty Level (Percent Estimated 2000)	Median Household Income (2000 $)
Champaign County	3.1	16.1	37,780
DeWitt County	7.4	8.2	41,256
Logan County	6.8	8.1	39,389
Macon County	6.7	12.9	37,859
McLean County	2.6	9.7	47,021
Piatt County	5.2	5.0	45,752
State of Illinois	6.3	10.7	46,590

Sources: BLS 2003a and 2003b; USCB 2000c

Table 2-12. Regional Employment Trends,1990 and 2000

County	Workers Employed Full- and Part-time, 1990	Workers Employed Full- and Part-time, 2000	Percent Change in Workers Employed, 1990 to 2000	Unemployment Rate, 1990	Unemployment Rate, 2000
Champaign	113,390	123,555	9.0	4.2	3.6
DeWitt	8382	8770	4.6	6.6	5.5
Logan	15,609	15,433	-1.1	5.4	3.9
Macon	65,419	72,246	10.4	4.0	5.2
McLean	80,513	109,249	35.7	6.6	3.4
Piatt	5882	6342	7.8	4.4	3.7

Sources: BEA 2001; County and City Data Books 1994a; USDOL 2000

Table 2-13 presents employment by proprietorship and industry, by county for 1990 and 2000. Nonfarm proprietorship employment (self-employed individuals) increased for all counties during the decade of the 1990s. Farm proprietorship employment and farm employment fell across all the counties, i.e., farmers were discontinuing farming by either retiring, going into another line of work, or being bought out, among other possibilities. The agricultural services, fishing, and the other-industry category, on the other hand, were mixed, increasing in those counties where data were available for 1990 and 2000, except for Champaign County where it declined. Construction held its own with minor fluctuations, except in Champaign and McLean Counties, where there was growth of 35 and 73 percent, respectively. Manufacturing either declined or held its own during the decade, except for Champaign County where it increased 22 percent. Other industries seeing increases in employment were transportation, public utilities (although DeWitt and Piatt Counties saw declines) and retail trade, which had increases across all counties except Piatt, which showed some minor declines.

Another strong growth industry was services, which showed strong growth across most of the counties, except for a 6.4-percent decline in Logan County. Government and government enterprises were stable employers, showing a decline of some significance only in Champaign County, where they declined by 12.5 percent.[a]

(a) The increases and decreases in jobs between the years 1990 and 2000 were obtained by dividing the 1990 total jobs by category (e.g., construction) and county into the year 2000 total jobs by category and county.

Table 2-13. County Employment by Proprietorship and by Industry, 1990 and 2000

	Champaign County		DeWitt County		Logan County		McLean County		Macon County		Piatt County	
Industry	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**
Proprietor-ships Proprietor employment	15,672	17,928	1951	2404	3386	3595	11,132	15,257	9295	9890	2012	2259
Nonfarm proprietor employment	14,048	16,459	1383	1888	2465	2818	9339	13,650	8466	9163	1439	1781
Farm proprietor employment	1624	1469	568	516	921	777	1793	1607	829	727	573	478
Industry Farm employment	1894	1701	675	625	1239	999	2117	1834	1079	962	708	581
Agriculture services, fishing, and other	1421	1207	97	192	178	(a)	1394	2230	532	615	96	(a)
Mining	164	88	25	18	(a)	(a)	72	46	251	100	25	(a)
Construction	3976	5367	273	453	(a)	542	2988	5167	4204	4391	322	294
Manufacturing	10,869	13,297	1084	962	2155	1685	8095	7826	14,730	14,076	515	553
Transportation and public utilities	2957	4213	1616	1332	434	579	3317	3392	4703	5494	282	246
Wholesale trade	3891	3415	313	293	554	550	2961	3024	2092	2365	250	348
Retail trade	17,743	21,814	1312	1497	2800	3119	14,212	18,960	11,012	12,698	1124	1069
Finance, insurance, and real estate	5625	7205	348	553	732	915	13,621	23,217	3530	3912	353	536
Services	27,642	32,689	1544	1564	4223	3951	19,848	29,077	17,075	20,623	1163	1425
Government and government enterprises	37,208	32,559	1095	1281	2537	2684	11,888	14,476	6211	7010	1044	1066

Source: BEA 2001
(a) Indicates that the data were not reported due to privacy concerns because individual firms in the county could be identified.

Table 2-14 is an aggregation of the data presented in Table 2-13 and totals employment by industry or business type for 1990 and 2000 for the same six counties. Between 1990 and 2000, non-farm proprietor employment increased 23 percent while farm proprietor employment declined by 12 percent and farm employment decreased by 13 percent. Based on the proprietorship decline and the fact that the “agricultural services, fishing, and other” category is up by 14 percent (recognizing that some data are missing for Piatt and Logan Counties), it would appear that the agricultural industry may be going through a consolidation phase of fewer but larger farms.

Table 2-14. Aggregated Employment by Industry or Business Type for Champaign, DeWitt, Logan, McLean, Macon, and Piatt Counties, 1990 and 2000

Industry or Business Type	1990 Employment	2000 Employment	Percent Change
Proprietorships			
Proprietor employment	43,448	51,333	18.1
Nonfarm proprietor employment	37,140	45,759	23.2
Farm proprietor employment	6308	5574	-11.6
Industry			
Farm employment	7712	6702	-13.1
Agricultural services, fishing, and other	3718	4244	Incomplete[(a)]
Mining	537	252	Incomplete[(a)]
Construction	11,763	16,214	Incomplete[(a)]
Manufacturing	37,448	38,399	2.5
Transportation and public utilities	13,309	15,256	14.6
Wholesale trade	10,061	9995	-0.7
Retail trade	48,203	59,157	22.7
Finance, insurance, and real estate	24,209	36,338	50.1
Services	71,495	89,329	24.9
Government and government enterprises	59,983	59,076	-1.5

Source: BEA 2001
(a) Incomplete, as some county data not available.

The growth industries that could be quantified over the decade between 1990 and 2000 include finance, insurance, and real estate (50 percent increase), the services industry (25 percent increase), and retail trade (23 percent increase). Manufacturing held its own in employment through the decade, increasing by approximately 2.5 percent. Generally, the economy across the region can be viewed as being economically diversified.

DeWitt County lost about 1000 jobs over the last 5 to 7 years as manufacturing firms have shifted jobs overseas or to other places in the United States and through businesses consolidating, merging, or going out of business.[b] The general thinking of county and city officials in the Clinton area is that the economy is soft but that they have reached bottom.[a] New firms are moving into the county and creating new jobs. However, the wages paid for these jobs are lower than the wages paid for the lost jobs.

Commodity prices are up, helping the agriculture sector. The market value of farmland is increasing, especially for the larger contiguous pieces of land, those from 160 to 320 ha (400 to 800 ac). Farmers in and around the Chicago area are selling their land for development and buying new farms involving non-taxable Starker exchanges. This has increased the price of farmland in and around Clinton to $4000 per acre.[b]

The number of building permits issued by the county is remaining stable, numbering about 170 permits annually from 2000 to 2003, of which new residential permits are holding steady between 42 and 45 annually over the same 4-year period (Brown 2004).

The county infrastructure is fairly new. A new courthouse and jail combination have been built. The county does not have any growth moratoriums in place. The City of Clinton also appears to have a fairly new, modern town hall.

The City of Clinton is going through a transition period economically. Manufacturing outsourcing and downsizing have made some realize that it is possible that Clinton may not return to the economy that characterized it during the decade of the 1990s and before. Clinton's strategic placement, midway between Decatur, Champaign-Urbana, Bloomington-Normal, and Springfield has suggested to some town and county officials that the City of

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(a) Personal interviews were conducted March 3, 2004, in the City of Clinton with Roger Cyrulik (Mayor of Clinton), Steve Lobb (Director of Public Works, Clinton), and Tim Followell (Administrative Assistant, Clinton). A group interview was conducted March 2, 2004, in Clinton, Illinois, with Duane Harris, (DeWitt County Board Chairman), Terry Ferguson (DeWitt County Board and Land Use Chairman), Sherrie Brown (Administrator, DeWitt County Zoning), Sandy Moody (DeWitt County Supervisor of Assessments), Dee Dee Rentmeister (Administrative Assistant, DeWitt County Board of Supervisors), and Christy Long (DeWitt County Treasurer).

(b) Personal interview conducted on March 2, 2004, in the City of Clinton, Illinois, with Sandi Thayer, Thayer Real Estate.

Clinton might begin to promote itself as a bedroom community to these larger communities, instead of a commercial manufacturing hub.[(a)]

The City of Clinton has had limits placed on its growth for a number of years for two reasons. First, there was an overtaxing of its sewer system in the early 1990s. The problem was caused by an inadequate combined storm water/sewer system, which has been corrected. The city has also expanded its water-treatment plant. Second, until approximately 1996, Clinton was locked into trust lands and could not annex new land into the town. The problem was resolved in 1996, and since then Clinton has annexed 80 ha (200 ac) and plans to extend utilities and other services to the annexed lands within the next 3 to 5 years.[(b)]

The City of Clinton has also taken advantage of tax increment financing districts to fund infrastructure improvements, such as street improvements (curbs, gutters, and a center turn lane on business U.S. Highway 51, which has greatly alleviated congestion through town). Under tax increment financing districts, tax revenues collected in a defined district are capped in the amount that goes to the town. Taxes collected above the cap go into a fund, which the town manages to pay for improvements within the district. Clinton also passed an increase to the local sales tax, which has also been used to fund improvements.[(b)]

Because of the presence of the CPS in DeWitt County, property taxes in Clinton and the county have been lower than those of neighboring counties. An owner of a house in McLean County (Bloomington-Normal) whose house was assessed at $150,000 would pay $4000 per year in property taxes. The same house in Clinton/DeWitt County would pay property taxes between $2800 to $3000 per year.[(c)]

The real estate market in both agricultural and residential housing is strong. Prices for residential housing are rising about 3 percent per year. The commercial sector is stable. The rental market, as the 2000 Census figures show, is very tight (see more detailed discussion in Section 2.8.2.5). There are not many vacancies, and those that do occur are filled quickly by word of mouth. According to two realtors, Clinton itself is increasingly becoming a bedroom

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(a) Group interview conducted March 2, 2004, in Clinton, Illinois, with Duane Harris, (DeWitt County Board Chairman), Terry Ferguson (DeWitt County Board and Land Use Chairman), Sherrie Brown (Administrator, DeWitt County Zoning), Sandy Moody (DeWitt County Supervisor of Assessments), Dee Dee Rentmeister (Administrative Assistant, DeWitt County Board of Supervisors), and Christy Long (DeWitt County Treasurer), and personal interview conducted March 3, 2004, in the City of Clinton, Illinois, with Stephen Vandiver (Economic Development Director, City of Clinton).

(b) Personal interview conducted March 3, 2004, in the City of Clinton, Illinois, with Stephen Vandiver (Economic Development Director, City of Clinton).

(c) Person interviews conducted on March 2, 2004, in the City of Clinton, Illinois, with Sandi Thayer, (Thayer Real Estate).

community to the larger cities of Champaign-Urbana, Springfield, Decatur, and Bloomington-Normal.[(a)]

There is also some building of residential housing in and around the City of Clinton. The average sale price of a used house is in the $75,000 to $80,000 range for three bedrooms, one-and-a-half baths, and a single-car garage on two-tenths of an acre. At the upper end, $285,000 will buy a five-bedroom, five-bath house on a one-and-one-third-acre lot. Houses are on the market an average of 60 to 75 days. Rents for apartments and residential housing range between $385 to $680 per month.[(b)]

Clinton Lake is heavily used for recreation, but its impact on the economy of Clinton is minimal.[(d)] In the vicinity of the lake, a 7.6-ha (19-ac) lot can be bought for $150,000.[(c)] A three-bedroom, two-bath house with unfinished basement, family room, and two fireplaces on 0.5 ha (1.3 ac) recently sold for $150,000.[(d)] No properties around the lake actually abut the lake. CPS owns the lake and 91 m (100 yards) up the shoreline from the lake. There is approximately a 10-percent differential in values between lake properties and properties in Clinton, with the lake properties being higher.[(d)]

In adjoining Piatt County and the Town of Monticello, the economy is better and more diversified. Monticello is close to neighboring Champaign County and the University of Illinois, as well as to Decatur. Highway I-72 runs past Monticello, and a number of its residents commute to jobs in Champaign-Urbana and Decatur. Like Clinton, it is a bedroom community to these larger cities.

Also like Clinton, Piatt County and Monticello have lost industry and jobs over the past few years, although some new industry has been attracted to the area. Those firms coming in are generally paying lower wages than those that left. Agriculture, a large part of the county's economy, is currently strong, with improvements in commodity prices and rising land values.[(d)]

(a) Personal interviews conducted on March 2, 2004, in the City of Clinton, Illinois, with Sandi Thayer (Thayer Real Estate), and on March 3, 2004, in the City of Clinton, Illinois, with Camill Tedrick, (General Manager, Brady Weaver Real Estate).

(b) Personal interviews conducted on March 2, 2004, in the City of Clinton, Illinois, with Sandi Thayer, (Thayer Real Estate), on March 3, 2004, with Stephen Vandiver (Economic Development Director, City of Clinton), and on March 3, 2004, with Camill Tedrick (General Manager, Brady Weaver Real Estate).

(c) Personal interview conducted March 2, 2004, in the City of Clinton, Illinois, with Sandi Thayer (Thayer Real Estate).

(d) Group interview conducted March 5, 2004, in the City of Monticello, Illinois, with Sue Gortner (Executive Director, Monticello Chamber of Commerce and Tourism), Bill Mitze (Mayor, Town of Monticello), Mary Jo Hetrick (Community and Economic Development Director, Monticello), Floyd Allsop (Superintendent of City Services, Monticello), and Lawrence J. McNabb, Ph.D. (Superintendent, Monticello Community Unit School District 25).

Four new subdivisions are underway in Monticello with 91 lots available in March 2004 (Monticello 2004). The infrastructure (water and sewer) is in place to support new construction for 5 years, with 25 to 30 new building permits annually. New housing construction ranges in price between $165,000 and $275,000.[(a)] Older houses with three bedrooms and one-and-a-half baths can be purchased for around $80,000. The price range for all houses sold in 2003 ranged from just under $50,000 to $350,000 (Monticello 2004). There are approximately 80 homes on the market at any given time, which in 2003 were on the market an average of 109 days.[(a)]

Mt. Pulaski, a small town in Logan County adjacent to and west of DeWitt County, is a bedroom community to Springfield, the State capitol. The economy in Logan County is considered strong. Agriculture, as in Piatt and DeWitt Counties, is a major component of Logan County economy. However, two prisons are the primary employers. Within the City of Mt. Pulaski, there are two industries: Inland Tools and Mt. Pulaski Products, Inc. Generally, the infrastructure (water, sewer, and roads) is sound, but the sewer system is being upgraded.[(a)] The rental market in Mt. Pulaski is tight, with no apartments available and limited places to build (only six lots are available and no houses are built on speculation – a buyer must enter into a contract before construction starts). If building does take place, it is considered important not to “overbuild,” i.e., building an expensive house with lots of amenities, because it would be difficult to sell.

A three-bedroom house in Mt. Pulaski would generally sell for between $75,000 and $100,000. When houses do become available, they sell rather quickly. Two houses were built in 2003, both by Habitat for Humanity.[(b)]

2.8.2.2 Taxes

AmerGen Energy Company, LLC, owner of CPS, pays annual property taxes to the following jurisdictions: DeWitt County, Clinton Community School District 15, and Harp Township (including Richland Community College District 537, Multi-Township Assessment District 3, Vespasian Warner Public Library District, and Mahomet Valley Water Authority).

Table 2-15 presents information on the total property taxes AmerGen pays to all jurisdictions, the total property taxes collected, and the percent of the total property taxes that are paid by AmerGen. The preponderance of taxes are paid to DeWitt County and Clinton School District 15. The AmerGen annual property tax payments to DeWitt County for the 7-year period 1996 to 2002 averaged approximately 66.5 percent of the total property taxes collected.

(a) Personal interviews conducted March 5, 2004, in the City of Mt. Pulaski, Illinois, with William Glaze (Mayor, City of Mt. Pulaski) and Michael R. Partridge (Director of Public Works, City of Mt. Pulaski).
(b) Personal interview conducted March 5, 2004, in the City of Mt. Pulaski Illinois with William Glaze (Mayor, City of Mt. Pulaski) and Michael R. Partridge (Director of Public Works, City of Mt. Pulaski).

Table 2-15. Total Property Tax Revenues Generated in DeWitt County and Other Taxing Districts, Total Property Taxes AmerGen Paid to These Jurisdictions, 1997 to 2002, and Percent of AmerGen Property Taxes Paid of Total Property Tax Revenues Collected

Year	Total Property Tax Revenues ($)	Property Tax Paid by AmerGen ($)	Percent of Total Property Taxes Paid to the Jurisdiction
1996	22,818,230	17,883,087	78
1997	23,120,605	17,801,100	77
1998	22,086,537	16,412,640	74
1999	21,071,703	15,398,610	73
2000	18,289,345	10,128,580	55
2001	17,524,729	9,558,990	55
2002	17,344,778	9,165,355	53

Source: Long 2004

Deregulation of the Illinois electric utility industry has had, and is continuing to have, a major impact on the finances of DeWitt County and other taxable entities receiving property tax revenue from AmerGen. For the period 2000 to 2002, the AmerGen property taxes paid to DeWitt County averaged 54.3 percent of the total property taxes received, or a drop of 21.5 percent from the average of the four previous years. This drop represents a transition period of declining property tax collections due to deregulation. Whereas in pre-deregulation years the property taxes paid were based on the depreciated book value of the CPS, post-deregulation the amount of property taxes paid will be based on the market value of power produced from the plant or by other methods. As of January 2006, negotiations are on going with AmerGen to arrive at a negotiated, more quantitatively based value for CPS. The approaches being explored include (1) an income method based on the value of sold power; (2) the cost today of building a new nuclear plant at the CPS site; and (3) market data – what have been the sale prices of recently sold nuclear power plants.[a] As reflected in Table 2-16, the assessed value of the plant has dropped from $708 million, county-assessed valuation in 1999, to $411 million (tentative) for 2003. Before 2000, the Illinois Power Company was valued at $470 million (1999) to a projected $165 million by 2003; the CPS is now owned by AmerGen (a subsidiary of Exelon Generation Company, LLC). The county currently is in a transition period from pre-deregulation to deregulation and does not know how CPS will be valued after 2005 (Moody 2004).[b]

(a) Telephone conversation with Frederic Lane, counsel; Robbins, Schwartz, Nicholas, Lifton and Taylor, Ltd.; Chicago, Illinois, January 17, 2006.
(b) Personal communication March 2, 2004, from Sandy Moody (DeWitt County Assessor).

Table 2-16. Real Estate Assessment of CPS Compared to Total Real Estate Assessment of DeWitt County

Year	DeWitt County Total Assessed Evaluation ($)	CPS Assessed Valuation ($)	Percent of CPS Assessed Valuation to County Total
1996	760,669,126	558,689,373	73
1997	751,432,800	540,000,000	72
1998	704,173,862	480,000,000	68
1999	707,995,785	470,000,000	66
2000	466,246,810	220,000,000	47
2001	453,754,329	210,000,000	46
2002	440,622,585	195,000,000	44
2003[(a)]	410,928,943	165,000,000	40

Source: Moody 2004
(a) Estimated.

2.8.2.3 Transportation

In Champaign-Urbana, four interstate highways cut through or end at the metropolitan area. Interstate-57 runs north-south through Champaign-Urbana and connects with Chicago to the north. Interstate-74 connects with the cities from the east and then runs northwest through Bloomington-Normal and Peoria and eventually connects with I-80 just east of Davenport, Iowa. Interstate-72 begins in Champaign and runs southwest, connecting Decatur with Champaign-Urbana to the northeast and Springfield to the west.

Bloomington-Normal has three interstate freeways running through it. Interstate-55 comes in from the southwest from Springfield, and runs northeast connecting to Chicago to the north. Interstate-74 comes in from the southeast and connects to Champaign-Urbana to the southeast and Peoria to the northwest. Interstate-39 comes in from Rockford, Illinois, to the north and intersects Interstates I-74 and I-55 at Bloomington-Normal.

Decatur has I-72 that connects it to Champaign-Urbana (terminating at I-57) to the northeast and Springfield to the west. Interstate-72 runs through Springfield to the west and continues west, while I-55 runs northeast and south, connecting Bloomington-Normal to the north and St. Louis to the south. All three cities (Decatur, Champaign-Urbana, and Bloomington-Normal) have regional airports offering flights to Chicago, Detroit, and other destinations.

The City of Clinton has two highways running through it. U.S. Highway 51 runs north-south through Clinton, connecting to Bloomington-Normal to the north and Decatur to the south. State Route 54 runs northeast to the southwest through Clinton, connecting with I-74 to the northeast and Springfield and to I-55 to the southwest.

With the improvements to its streets, Clinton has greatly alleviated congestion during shift changes at CPS. The CPS employs 550 workers. During refueling outages the temporary workforce can increase to 1300 for a period up to three weeks (Exelon 2006b). Access to the CPS site is via good roads. Congestion only exists at shift changes and is short-lived, usually dissipating within a half-hour.

2.8.2.4 Aesthetics and Recreation

Clinton Lake State Recreation Area is 3760 ha (9300 ac), including Clinton Lake, which is the cooling water source for the current CPS. The lake, 1981 ha (4895 ac) in size, is located just 3 miles east of the City of Clinton. Numerous recreational sites are located around the reservoir, including boat ramps, camping sites, and picnic areas (IDNR 2004b). Although AmerGen owns the lake and 91 m (100 yards) up the shoreline from the lake, public access is available to most of the lake. However, for security purposes, a small part of the lake is off limits to public access, primarily around the plant itself and its water intake structures.

Clinton Lake State Recreation Area is heavily used for recreation. Recreational activities include boating, hiking, swimming, and camping, among other activities. Fishing has been described as outstanding, with species available including crappie, catfish, walleye, stripers, bass, and bluegill (IDNR 2004c).

The CPS can be seen from several vantage points around Clinton Lake. The terrain around the lake is gently undulating and wooded. From these areas, most of the CPS structures are screened from public view. Noise from the plant is not particularly noticeable, even from vantage points where the plant can be clearly seen.

2.8.2.5 Housing

The largest number of current employees at CPS's nuclear facility live in three areas: approximately 30 percent live in DeWitt County, 30 percent in Macon County (Decatur), and 20 percent in McLean County (Bloomington-Normal). The remaining 20 percent are scattered in other communities, generally within a 80-km (50-mi) radius of the ESP site (Exelon 2004a).

Within the 80-km (50-mi) radius, residential areas are found in the cities, towns, and smaller communities with farmsteads scattered throughout the area. Rental property is scarce in the rural regions, but is found in the larger cities such as Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield. Near the vicinity of the ESP site, residential areas are generally older single-family residences and mobile homes. Newer residential developments are primarily located in the four cities previously mentioned.

Table 2-17 provides the number of housing units and housing unit vacancies for the region of potential impact for 1990 and 2000 for Champaign, DeWitt, Logan, McLean, Macon, and Piatt

Table 2-17. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Approximate Percentage Change (1990 to 2000)
Champaign County			
Total Housing Units	68,416	75,280	10.0
Occupied Units	63,900	70,597	10.5
Owner-occupied	34,857	39,329	12.8
Renter-occupied	29,043	31,268	7.7
Vacant Units	4516	4683	3.7
DeWitt County			
Housing Units	6942	7282	4.9
Occupied Units	6488	6770	4.3
Owner-occupied	4599	5076	10.4
Renter-occupied	1889	1694	-10.3
Vacant Units	454	512	12.8
Logan County			
Housing Units	11,638	11,872	2.0
Occupied Units	11,033	11,113	0.7
Owner-occupied	7476	7925	6.0
Renter-occupied	3557	3188	-10.4
Vacant Units	605	759	25.5
McLean County			
Housing Units	49,164	59,972	22.0
Occupied Units	46,796	56,746	21.3
Owner-occupied	29,696	37,710	27.0
Renter-occupied	17,100	19,036	11.3
Vacant Units	2368	3226	36.2
Macon County			
Housing Units	50,049	50,241	0.4
Occupied Units	45,996	46,561	1.2
Owner-occupied	32,268	33,345	3.3
Renter-occupied	13,728	13,216	-3.7
Vacant Units	4053	3680	-9.2
Piatt County			
Housing Units	6227	6798	9.2
Occupied Units	5934	6475	9.1
Owner-occupied	4539	5191	14.4
Renter-occupied	1395	1284	-8.0
Vacant Units	293	323	10.2

Sources: USCB 2000d; County and City Data Books 1994b counties. Total housing units further subdivide into owner-occupied, renter-occupied, and vacant. The percentages change for each classification over the decade of the 1990s is presented in the table.

Generally, the counties with the larger populations (Champaign, McLean, and Macon) have more available vacant housing. The percentage change in the number of vacant units between 1990 and 2000 in the region ranges from 3.7 percent (Champaign County) to 36.2 percent (McLean County). The counties with smaller populations (e.g., Piatt, DeWitt, and Logan) show a percent change in vacant units ranging between 10.2 percent (Piatt) and 25.5 percent (Logan). Macon County had a decline in the number of vacant units (-9.2 percent).[a]

In 2000, there were 211,445 total housing units for Champaign, DeWitt, Logan, McLean, Macon, and Piatt Counties. Of that total, 69,686 were renter-occupied (33 percent of the total). Vacant units numbered 13,183 (6.2 percent of the total for 2000).[b]

Table 2-18 presents more detailed 2000 Census data on vacant housing units for communities close to the ESP site: Clinton, Farmer City, Monticello, and Lincoln. Of the 238 vacant houses in Clinton, 110 were for rent. Of its 426 vacant units, Lincoln had 124 units available for rent. Of its 80 vacant units, Monticello had 14 units available for rent. Farmer City had 76 vacant units and 29 units available for rent.

2.8.2.6 Public Services

Public services and facilities consist of public utilities (water and waste water treatment), police, fire departments, medical services, social services. Education (schools) is discussed in Section 2.8.2.7. Most of these services are located in municipal boundaries and are near population centers (Exelon 2006a).

Water and Waste Water Treatment

In the vicinity of the ESP site, drinking water is primarily obtained from groundwater via wells. The Clinton Sanitary District Sewage Treatment Plant serves the waste water needs of the City of Clinton. In the region, rural communities generally have private wells for water and septic systems for sanitary wastes. Larger communities obtain water from groundwater extraction wells and are served by public waste water treatment systems. Individual residents in rural

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(a) These values were obtained by dividing 1990 housing data by category (e.g., vacant units) into the 2000 housing data of the same category.
(b) Values were obtained by totaling each category (e.g., total housing units) by county for 2000 and dividing that total into the totals (over all counties) for the categories “renter occupied” and “vacant units.”

Table 2-18. Vacant Housing Units for Clinton, Farmer City, Monticello, and Lincoln, 2000

	Number	Percent of Total Vacant Units
Clinton		
Vacant housing units	238	
For rent	110	46.2
For sale only	37	15.5
Rented or sold, not occupied	24	10.1
For seasonal, recreational, or occasional use	20	8.5
For migratory workers	0	0.0
Other vacant	47	19.7
Farmer City		
Vacant housing units	76	
For rent	29	38.2
For sale only	12	15.8
Rented or sold, not occupied	1	1.3
For seasonal, recreational, or occasional use	8	10.5
For migratory workers	0	0.0
Other vacant	26	34.2
Monticello		
Vacant housing units	80	
For rent	14	17.4
For sale only	17	21.3
Rented or sold, not occupied	11	13.8
For seasonal, recreational, or occasional use	4	5.0
For migratory workers	0	0.0
Other vacant	34	42.5
Lincoln		
Vacant housing units	426	
For rent	124	29.1
For sale only	89	20.9
Rented or sold, not occupied	101	23.7
For seasonal, recreational, or occasional use	14	3.3
For migratory workers	0	0.0
Other vacant	98	23.0

Source: USCB 2000e

areas obtain their water primarily from wells. A survey was performed for water and water facilities in the region, and the facilities were found to have excess capacity to accommodate potential population increases (Exelon 2006a). An independent analysis conducted by the NRC staff confirms Exelon's finding (Tables 2-19 and 2-20).

Table 2-19 summarizes the source and daily peak, average, and excess capacity of water consumed in the major towns and cities within an 80-km (50-mi) radius of the ESP site. Excess capacity exists in the public water supply systems of all major cities and towns within the region. Springfield has the largest water-treatment capability. Its peak demand is 144 million L/d (38 million gallons per day [mgd]), average daily demand is 83 million L/d (22 mgd), and excess capacity is 30 million L/d (8 mgd). Closer to the ESP site, the Cities of Clinton, Farmer City, Monticello, and Lincoln all have excess capacity ranging from 1.1 million L/d (0.3 mgd) (Clinton) to 5.7 million L/d (1.5 mgd) (Lincoln). The combined excess capacity for these four small towns, all within 25 miles of the CPS, is 10 million L/d (2.7 mgd).

Table 2-20 summarizes the type and treatment capacity, current load, and excess capacity of the waste water treatment facilities in the same cities and towns within 80 km (50 mi) of the ESP site. Excess capacity exists in the public waste water treatment systems of all major cities and towns within the region. Springfield has the largest waste-treatment excess capacity. Its daily peak is 227 million L/d (60 mgd), current load of 83 million L/d (22 mgd), and excess capacity of 144 million L/d (38 mgd). Closer into the ESP site, the Cities of Clinton, Farmer City, Monticello, and Lincoln all have excess capacity ranging from 1.6 million L/d (0.4 mgd)

Table 2-19. Public Water Supply Systems in Select Towns and Cities in the Region of the Exelon ESP Site

Water System	Source	Peak Daily Demand, Million L/d (mgd)		Average Daily Use, million L/d (mgd)		Excess Capacity, million L/d (mgd)	
Clinton (DeWitt)	Well	6.4	(1.7)	5.3	(1.4)	1.1	(0.3)
Monticello (Piatt)	Well	3.4	(0.9)	2.5	(0.7)	1.3	(0.4)
Farmer City (DeWitt)	Well	0.8	(0.2)	0.7	(0.2)	1.9	(0.5)
Lincoln (Logan)	Well	12.5	(3.3)	9.5	(2.5)	5.7	(1.5)
Champaign-Urbana (Champaign)	Well	125.3	(33.1)	73.1	(19.3)	26.3	(6.9)
Decatur (Macon)	Lake	166.2	(43.9)	146.5	(38.7)	27.5	(7.3)
Bloomington (McLean)	Lake	75.7	(20.0)	141.6	(11.0)	7.6	(2.0)
Normal (Macon)	Well	19.5	(5.2)	15.2	(4.0)	17.0	(4.5)
Springfield (Sangamon)	Lake	143.9	(38.0)	83.3	(22.0)	30.3	(8.0)

Sources: IDOCEO 2002, 2003

Table 2-20. Waste Water Treatment Systems in Select Towns and Cities in the Region of the Exelon ESP Site

Water System	Type of Treatment	Treatment Capacity, million L/d (mgd)		Current Load, million L/d (mgd)		Excess Capacity, million L/d (mgd)	
Clinton (DeWitt)	Tertiary	6.4	(1.7)	4.9	(1.3)	1.6	(0.4)
Monticello (Piatt)	Tertiary	3.8	(1.0)	2.1	(0.6)	1.7	(0.5)
Farmer City (DeWitt)	Tertiary	3.4	(0.9)	1.4	(0.4)	2.0	(0.5)
Lincoln (Logan)	Tertiary	45.0	(12.0)	19.0	(5.0)	26.0	(7.0)
Champaign-Urbana (Champaign)	Tertiary	87.8	(23.2)	65.1	(17.2)	22.6	(6.0)
Decatur (Macon)	Secondary	155.2	(41.0)	117.0	(31.0)	38.0	(10.0)
Bloomington-Normal (McLean)	Tertiary	118.1	(31.2)	61.0	(16.0)	57.5	(15.2)
Springfield (Sangamon)	Tertiary	227.0	(60.0)	83.0	(22.0)	144.0	(38.0)

Sources: IDOCEO 2002, 2003, 2004, 2005

(Clinton) to 26 million L/d (7 mgd) (Lincoln). The combined excess capacity for these four small towns, all within 25 miles of the CPS site, is 31.3 million L/d (8.4 mgd).

"Secondary treatment" usually employs a biological process whereby a large population of micro-organisms help converts the remaining organic material into other forms, which can be easily separated into solids and clear liquids (Reclamation District 2006). Secondary treatment is the minimum treatment requirement for most municipal sewage treatment plants (LGAN 2006). "Tertiary treatment" is required when the final effluent must be so clean that 95 percent or more of the contaminants must be removed by waste-water treatment. Tertiary treatment may include filtration, removal of ammonia and other contaminants, and disinfection to destroy bacteria causing human diseases (Reclamation District 2006). Should a town or city be limited in its growth because of water quality issues associated with secondary treatment, tertiary treatment, because it is more advanced technologically, can be employed and thereby help alleviate the growth moratorium, allowing growth to occur.

Public water supply and waste water treatment are not a constraint to growth in the vicinity of the ESP site, assuming that growth increases hold to the historical norm. However, there are no limitations on new sources of water from groundwater. In addition, most treatment plants located in the area have reserve treatment capacity.

Police, Fire, and Medical Services

Within the 16-km (10-mi) radius of the ESP site, there is one fire department and there are two police (city police and county sheriff) departments that serve the City of Clinton. In the region of interest, there are a total of 89 fire departments and 75 police departments. Outside of the major cities of the area (Decatur, Champaign-Urbana, Bloomington-Normal, and Springfield), communities typically share fire-fighting services (Exelon 2006a).

Within the 16-km (10-mi) radius of the ESP site, there are two nursing homes and one hospital serving Clinton. Within the (80-km [50-mi]) region, there are 52 hospitals and 84 nursing homes. Exelon concludes that the projected capacity of public services is adequate and is expected to expand modestly to meet the demands of a slight population growth (Exelon 2006a). Annual population growth projections of less than 0.8 percent a year would tend to support this conclusion (see Table 2-8).

Social Services

Social services in Illinois are overseen at the State level of government by the Department of Human Services, which is the largest agency in Illinois, with more than 15,000 employees and an annual budget of nearly $5 billion. The services of the agency are provided through nearly 200 local offices and in partnership with a network of local providers that reaches every part of Illinois. The services touch the lives of one out of five Illinois citizens in the course of a year (IDHS 2006).

The Department of Human Services serves Illinois citizens through seven main programs: (1) alcoholism and substance abuse treatment and prevention services; (2) developmental disabilities; (3) health services for pregnant women and mothers, infants, children, and adolescents; (4) prevention services for domestic violence and at-risk youth; (5) mental health; (6) rehabilitation services; and (7) welfare programs, including temporary assistance for needy families, food stamps, and child care (IDHS 2006).

2.8.2.7 Education

The public school systems in the region are organized into 110 primary, secondary, or unit school districts. Within DeWitt County, there are two school districts. The Blue Ridge Community School District 18 is based in Farmer City, Illinois. It has one high school (enrollment 285), a junior high school (enrollment 150), an elementary school (enrollment 240), and a pre-school (enrollment 290) (School 2004a). Clinton School District 15 has one high school (enrollment 750), a junior high school (enrollment 500), and three elementary schools (enrollment 1050, including pre-school) (School 2004b). Clinton School District 15 is the main beneficiary of the current CPS tax base[a] (Exelon 2006a).

Over the last several years, Clinton School District 15 has been meeting obligations by cutting its budget by $3 million and spending reserves. For the first time since 1965, the school district had to go before the voters in mid-March (2004) to request an increase in the tax rate to $1.20 per thousand of assessed valuation,[b] only to have it defeated by a three-to-one margin. It has seen the percentage of the property taxes from AmerGen to total property taxes collected in DeWitt County decline from 80 percent in 1996 to 53 percent in 2002.[b]

Monticello Community Unit School District's 25 schools are financially stable. The district has had some financial strain from their reliance on the corporate profit tax because of the recession and firms closing and leaving the area. There have been recent improvements in corporate profit tax collection as a result of renewed economic growth in the area. The income tax for corporations is 7 percent, which includes the 2.5-percent personal property replacement tax (Lawrence County 2004). A $21-million construction phase has been undertaken, and with the new construction there will be excess capacity in the school system.[c]

A survey of class size of some schools in the region was performed and found that of those districts surveyed (a total of 69), 67 percent of all the schools within these districts have class sizes at or below the national average (Exelon 2004c). From this, Exelon concluded that this is an indication that there is sufficient capacity in the classrooms for a small increase in population. Although the Blue Ridge and Clinton school districts were not included in the Exelon survey, the NRC staff interviewed the superintendents of the Clinton and Monticello school districts. They found classrooms to be adequate for the numbers of students.[d]

There are three community colleges and eight 4-year colleges and universities in the region. Richland Community College District has students on the main campus in Decatur and is a beneficiary of the Exelon property taxes. It has a full-time equivalent enrollment of 1155.[e] Other 4-year colleges and universities with enrollment are as follows (Exelon 2006a): Eureka College, Eureka (525); Illinois Central College, Peoria (13,930); Illinois State University, Bloomington (20,504); Illinois Wesleyan, Bloomington (2028); Millikin University,

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(a) CPS is owned by AmerGen Energy Company, LLC, a subsidiary of Exelon Generating Company, LLC.
(b) Personal interview March 3, 2004, with Roger Little (Superintendent, Clinton Unit School District 15).
(c) Personal interview conducted on March 5, 2004, in the City of Monticello, Illinois, with Lawrence J. McNabb (Superintendent, Monticello Community School District 25).
(d) Personal interviews conducted on March 3, 2004, in the City of Clinton, Illinois, with Roger A. Little (Superintendent, Clinton Unit School District 15), and on March 5, 2004, in the City of Monticello, Illinois, with Lawrence J. McNabb (Superintendent, Monticello Community School District 25).
(e) Personal communication February 11, 2004, with Nancy Cooper (Dean, Enrollment Services, Richland Community College, Decatur, Illinois).

Decatur (2079); Parkland College, Champaign (9280); Southern Illinois University, Carbondale and Springfield (4334); and University of Illinois, Champaign-Urbana (36,936).

2.9 Historic and Cultural Resources

This section discusses the cultural background and the known historic and archaeological resources at the Exelon ESP site and in the surrounding area of DeWitt County. It also details the approach that will be taken to protect cultural resources, and describes consultation efforts accomplished to date.

2.9.1 Cultural Background

The area in and around the ESP site has a rich cultural history and a substantial record of significant prehistoric and historic resources. In March 2004, NRC staff conducted a site file search at the Illinois State Historic Preservation Agency (IHPA). The site files identified a total of 95 archaeological sites and isolated finds within a 3.2-km (2-mi) radius of the CPS unit. Ten archaeological sites contained features or artifacts dating from the historic period (after A.D. 1600); 92 sites contained features and/or artifacts from the prehistoric period.

The Salt Creek River system flows through the area and influenced settlement in the area. Of the 92 sites with prehistoric remains, 22 sites are dateable. The record indicates that prehistoric occupation of the area began in the Early Archaic period (ca. 8000 B.C. - 1000 B.C.) and extended through the Woodland Period (1000 B.C. - A.D. 900) and the Mississippian Period (A.D. 900 - 1600).

When Euroamericans arrived in the area in approximately 1600 A.D., the area was occupied by American Indian groups associated with the Illini Confederacy and the Kickapoo, who remained in the area until the 1820s. Present-day tribes with ancestral ties to the area include the Kickapoo of Kansas Tribal Council, the Kickapoo of Oklahoma Business Committee, the Kickapoo Traditional Tribe of Texas, the Eastern Delaware Tribe, the Delaware Tribe of Western Oklahoma, and the Peoria Tribe of Indians of Oklahoma.

The historic period in this region began with the pioneers who entered the area as part of the general westward expansion. The first permanent settlers came from Kentucky and Tennessee to farm the land in the 1830s. Clinton emerged as a major commercial center with the arrival of the Illinois Central Railroad in 1854. DeWitt County retains many of the rural characteristics that were part of its early history.

2.9.2 Historic and Cultural Resources at the Exelon ESP Site

The original CPS project consisted of the CPS site and the portion of the North Fork Salt Creek dammed to make Clinton Lake, which supports operations. Most of the lake was subsequently leased to the IDNR and has been developed as the Clinton State Recreation Area. Although much of the current CPS unit consists of disturbed areas impacted by industrial facilities, roads, parking lots, and former laydown yards, portions of the site remain undisturbed or minimally disturbed.

A Phase 1 archaeological survey was conducted in the early 1970s prior to the construction of the CPS unit. In addition to the area proposed for the CPS unit, the survey included selected portions of the Salt Creek floodplain and adjacent uplands (Lewis 1973), recording 132 sites. The exact areas surveyed are not known, but were concentrated in the North Fork Salt Creek drainage, which was planned to be dammed to create a lake to serve water intake and outflow needs of the CPS unit. Ten sites that had diagnostic evidence, such as a projectile point to provide an age, were recommended for additional investigation.

The Illinois State Museum performed archaeological testing of the 10 recommended sites in 1974 (Lewis 1975). In 1975, the Museum conducted an additional archaeological excavation at the Pabst Site (11DW32), located near the proposed water intake structure, and recovered a substantial amount of archaeological data (Lewis 1976). The Pabst Site was an area that prehistoric peoples repeatedly occupied beginning approximately 4000 years ago. The site appears to have been a base camp from which small task groups departed to hunt and gather foods to bring back to use at the camp. Remains from these activities formed an archaeological deposit 1 m (3.3 ft) thick and 2 ha (5 ac) in size. Lewis reports that he prepared an application for nominating the Pabst Site to the National Register of Historic Places and that the application was accepted on April 30, 1975 (Lewis 1976); however, no records of this acceptance were found at the IHPA in 2004.

Also prior to the original construction, research identified the Valley Mill (ca. 1850; 11DWH24), located on the North Fork, and eight iron bridges (ca. 1870s), which crossed the North Fork and Salt Creek, as historic resources worthy of attention. All of these would be inundated by the proposed reservoir. Plans were made to move two of the bridges for use as footbridges and to move the Valley Mill to higher ground where the DeWitt County Museum Association would assist with interpretation to the public (AEC 1974). Neither of these events ever occurred.

In 2000, Dynegy Midwest Generation, Inc., funded an archaeological survey prior to construction of a wastewater treatment plant to be located near the CPS water outfall structure (Howe 2000). Background historical research indicated the presence of a road through the area and a historic structure as early as 1875 on an 32-ha (80-ac) parcel owned by P. Wakefield. During the archaeological survey, one historic site (11DW360) was recorded, characterized by a small scatter of historic debris such as glass, pottery, and brick.

Subsequent shovel-testing failed to identify any intact prehistoric or historic deposits, and no additional work was recommended.

To determine if significant impacts to historic and cultural resources could result from this project, the National Historic Preservation Act of 1966, Section 106 process was integrated with the National Environmental Policy Act of 1969 process, in accordance with 36 CFR 800.8. As part of this integration, an Area of Potential Effect (APE), that is, the area within which cultural and historical sites could be impacted, was defined as

> …the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities associated with the construction and operation of the new unit(s), and construction and operation of new transmission lines that may follow parallel with some of the existing transmission line systems now serving the Clinton Power Station (NRC 2003).

The APE includes the areas where new facilities and associated infrastructure are planned. This includes all areas where construction laydown yards may be located. Because laydown yards and, in some cases, associated infrastructure have yet to be identified, the APE is that area within the current CPS unit boundary. Disturbed areas within the APE are considered because the extent of disturbance in many areas is not known. Previous laydown yards, for example, are clearly disturbed at the surface, but that disturbance may be relatively shallow. Other areas were farmed previously, causing significant disturbance within the plow-zone; however, plowed fields are not considered totally disturbed because prehistoric archaeological deposits are often found below the plow-zone in Illinois. If these areas were selected for siting portions of a new nuclear unit, additional work might need to be conducted, such as tilling the area, conducting an archeological pedestrian survey, and performing shovel-tests.

Within the APE, previous cultural resource identification efforts indicate the presence of several archaeological sites and the potential for additional sites. The most significant known site is the Pabst Site (11DW32), located near the proposed water-intake structure. The Pabst Site was excavated in 1975 to mitigate the effects of the CPS unit; a large number of prehistoric artifacts from a Late Archaic midden, dated approximately 4000 to 6000 years ago, were recovered (Lewis 1976). The site is currently under water, but may be exposed when construction of the water intake structure begins. According to the project archaeologist who performed the original excavations at the Pabst Site, the site may no longer exist:

> It is extremely doubtful that further archaeological investigations will ever be undertaken at Pabst. A visit to the site in February of 1976 showed that much of the site was buried under fill from earthmoving along the crest of the bluff. The construction of the ultimate heat sink will undoubtedly remove more of the site area. Finally, the reservoir waters will eventually cover what remains, if anything (Lewis 1976).

Two additional sites (11DW223 and 224) were identified during the original 1974 survey in the area between the ESP unit new power plant footprint and its proposed cooling towers. Both sites are small prehistoric occupations of unknown cultural affiliation. These sites were not further investigated due to the lack of diagnostic material. Nevertheless, the presence of these sites and the discovery of similar sites nearby suggest that there is high potential for prehistoric sites in this general area (Ahler 1990a, 1990b). Prior to construction, this area will need to be further investigated using appropriate methods such as tilling, surveying, and shovel-testing.

Previous investigations did not discover any human remains. During initial consultation efforts with American Indian tribes formerly from this area, some of the tribes have requested they be contacted if human remains are discovered during construction.

Documentary research indicates that a 19th-century road and several farms were located in the area to be impacted by the proposed construction (Warner and Beers 1875; Ogle 1915). Previous investigations have not identified significant archaeological resources associated with these farms; however, the possibility remains that such deposits exist.

No analysis of historic and cultural resources was conducted for the transmission line rights-of-way. The full extent of potential land-use impacts in the transmission line rights-of-way can be estimated only after following the Federal Energy Regulatory Commission process for connecting new large generation sources to the grid. This process is detailed more specifically in Section 3.3.

2.9.3 Consultation

In December 2003, the NRC initiated consultation on the proposed action by writing the IHPA and the Advisory Council on Historic Preservation. Also in December 2003, the NRC initiated consultations with the Kickapoo of Kansas Tribal Council, the Kickapoo of Oklahoma Business Committee, the Eastern Delaware Tribe, the Delaware Tribe of Western Oklahoma, the Peoria Tribe of Indians of Oklahoma, and the Kickapoo Traditional Tribe of Texas by first calling and then following up with a letter. In the letters, the NRC provided information about the proposed action, indicated that review under the National Historic Preservation Act of 1966 would be integrated with the NEPA process in accordance with 36 CFR 800.8, invited participation in the identification and possible decisions concerning historic properties, and invited participation in the scoping process (see Appendix F).

On December 18, 2003, NRC conducted a public scoping meeting in Clinton, Illinois. No comments or concerns regarding historic and cultural resources were made at this meeting. The NRC did receive two letters in response to its earlier communications. The Peoria Tribe indicated that it had no objection to the proposed construction, but requested that if human remains or objects falling under Native American Graves Protection and Repatriation Act were discovered, construction would stop until State and Tribal representatives were contacted

(Froman 2004). The Delaware Nation Native American Graves Protection and Repatriation Act Office requested that NRC work with the State Historic Preservation Officer to take appropriate steps and that the Delaware Nation be kept informed of any changes and cultural work completed; they also requested that work stop and that the State and tribe be contacted in the case of inadvertent discovery of human remains or other archaeological materials (Wahahrockah-Tasi 2003).

During discussions with the NRC staff in March 2004, the IHPA indicated that cultural resource studies should be conducted prior to construction, depending on where construction would occur. Federal, State, local, and Tribal organizations as well as members of the public were afforded the opportunity to comment on the draft version of the ESP EIS.

2.10 Environmental Justice

Environmental justice refers to a Federal policy under which each executive agency identifies and addresses, as appropriate, disproportionately high and adverse impacts on human health or environmental effects of its programs, policies, and activities on minority[(a)] or low-income populations. Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969. The Council on Environmental Quality has provided guidance for addressing environmental justice (CEQ 1997). Although it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews. The staff uses as guidance the NRC Office of Nuclear Reactor Regulation office instruction number LIC-203 (NRC 2004a[(b)]).

The staff examined the geographic distribution of minority and low-income populations within an 80-km (50-mi) radius of the CPS site, employing the 2000 Census (USCB 2000f, 2000g). The analysis was also supplemented by field inquiries to planning, economic development, real estate, and social service agencies and to county and city officials.[(c)]

(a) Minority categories are defined as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; Black races; Hispanic ethnicity; and "other," considered a separate minority category. The 2000 Census included multi-racial data. Some minority populations can be composed of one or more minority races (USCB 2000f).

(b) NRC issued a policy statement on Environmental Justice and an update to LIC 203 (see 69 FR 52040 and NRC 2004a, respectively).

(c) Personal interviews were conducted: on March 2, 2004, with Sandi Thayer (Thayer Real Estate), Duane Harris (DeWitt County Board Chairman), Terry Ferguson (DeWitt County Board and Land Use Chairman), Sherrie Brown (Administrator, DeWitt County Zoning), Sandy Moody (DeWitt County Supervisor of Assessments), Dee Dee Rentmeister (Administrative Assistant, DeWitt County Board of Supervisors), and Christy Long (DeWitt County Treasurer); on March 3, 2004, with Roger Cyrulick (Mayor of Clinton), Steve Lobb, (Director of Public Works, Clinton), Tim Followell (Administrative Assistant, Clinton), Steven Vandiver (Economic Development Director, Clinton), Camill Tedrick (General Manager, Brady Weaver Real Estate), Cheryl Leitz (Executive Director, DeWitt County

For the purpose of the staff's review, a *minority population* exists if the percentage of any minority or aggregated minority category within the census block groups[a] within the 80-km (50-mi) radius of the proposed ESP site exceeds the corresponding percentage of minorities in the entire State of Illinois by 20 percent, or if the corresponding percentage of minorities within the census block group is at least 50 percent. A *low-income population* exists if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the entire State of Illinois by 20 percent, or if the corresponding percentage of low-income population within a census block group is at least 50 percent. For counties and census block groups within an 80-km (50-mi) radius of the ESP site, the percentage of minority and low-income populations is compared to the percentage of minority and low-income populations in Illinois, as applicable.[b]

Exelon followed the convention of including census blocks in its evaluation. It used 2000 Census data for both minority and low-income populations. However, their approach to assessing minority and low-income populations did not follow NRC guidance. Exelon's reason for not following NRC guidelines was the presence of one Native American in one census block (the only person in that census block), 1.2 km (0.75 mi) from the ESP site (Exelon 2006a).

Exelon aggregated within the 80-km (50-mi) radius the total population and the total minority and low-income populations. It then calculated the percentage of total minority and low-income populations in the region and compared the resultant figures against the percentage of minority and low-income populations in Illinois. The total minority population within the region was 13 percent, while that of Illinois was 39 percent. For low-income populations, 10 percent of the population within the region had incomes below the poverty level, compared to the State of Illinois as a whole, which had 11 percent of the population below the poverty level (Exelon 2006a). By not following NRC convention, Exelon under-emphasized individual census block groups where the corresponding percentage of minority or low-income populations

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Human Resources Center), and Roger Little (Superintendent, Clinton Unit School District 15); and on March 5, 2004, with Sue Gortner (Executive Director, Monticello Chamber of Commerce and Tourism), Bill Mitze (Mayor, Town of Monticello), Mary Jo Hetrick (Community and Economic Development Director, Monticello), Floyd Allsop (Superintendent of City Services, Monticello), and Lawrence J. McNabb (Superintendent, Monticello Community Unit School District 25).

(a) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the U.S. Census Bureau collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census-data users in accordance with U.S. Census Bureau guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (USCB 2001).

(b) Low-income households should be identified using the annual statistical poverty threshold from the U.S. Census Bureau (NRC 2004a).

exceed the 20- or 50-percent criterion. However, in deriving the minority and low-income maps contained in the ER, Exelon showed all census blocks with minority or low-income populations, including blocks containing 0 to 5 percent minority or low-income populations (see Figures 2.5-8 and 2.5-9 of the ER) (Exelon 2006a).

The staff employed the Geographical Environmental and Siting (GEn&SIS) database and followed the convention of using census block groups to determine distribution of minority populations within the 80-km (50-mi) radius (GEn&SIS 2004). Figure 2-6 shows the distribution of minority populations (shaded areas) within the 80-km (50-mi) radius. All census blocks with at least 50 percent of their area within the 80-km (50-mi) radius around the CPS site are included in the analysis. Data from the 2000 Census characterize 32.2 percent of the Illinois population as minority (USCB 2000a). The percentage that the staff determined is different from the percentage that Exelon determined (39 percent). Applying the NRC criterion of "more than 20 percent greater," the census block groups were identified to contain minority populations. Within the 80-km (50-mi) radius, census block groups containing minority populations are concentrated in the larger cities of Champaign-Urbana, Decatur, and Springfield. The shaded area in Logan County (the county adjacent and west of DeWitt County) is where two prisons are located.

Figure 2-7, generated using the GEn&SIS database, shows the distribution of low-income populations (shaded areas) within the 80-km (50-mi) radius. All census blocks with at least 50 percent of their area within the 80-km (50-mi) radius around the CPS site are included in the analysis. Data from the 2000 Census classified 10.7 percent of Ilinois individuals as low-income (USCB 2000b). Applying the NRC criterion of "more than 20 percent greater," the census block groups were identified to contain low-income populations. Within the 80-km (50-mi) radius, census block groups containing low-income populations are concentrated in the larger cities of Champaign-Urbana, Decatur, Bloomington-Normal, and Springfield.

2.11 Related Federal Projects

The staff reviewed the possibility that activities of other Federal agencies might impact the granting of an ESP to Exelon. Any such activities could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency for preparation of the EIS (10 CFR 51.10(b)(2)).

After reviewing the Federal activities in the vicinity of the ESP site, the staff determined that there were no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparation of this EIS. Future Federal actions related to this project include permits and licenses that may be required at the time of the CP or COL application. Other Federal projects may be required at the CP or COL stage, such as

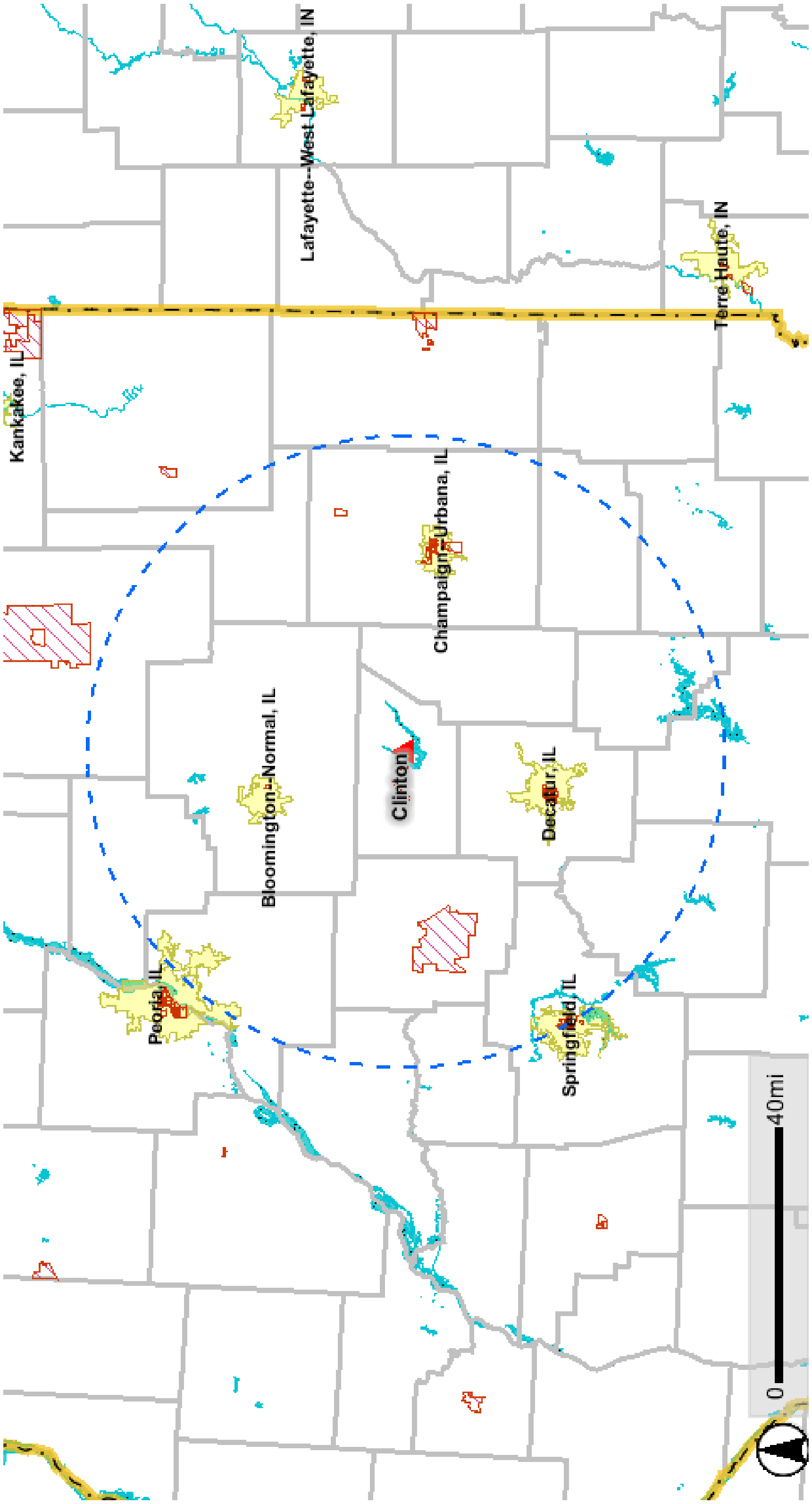

Figure 2-6. Geographic Distribution of Minority Populations (shown in shaded areas) Within an 80-km (50-m) Radius of Exelon ESP Site

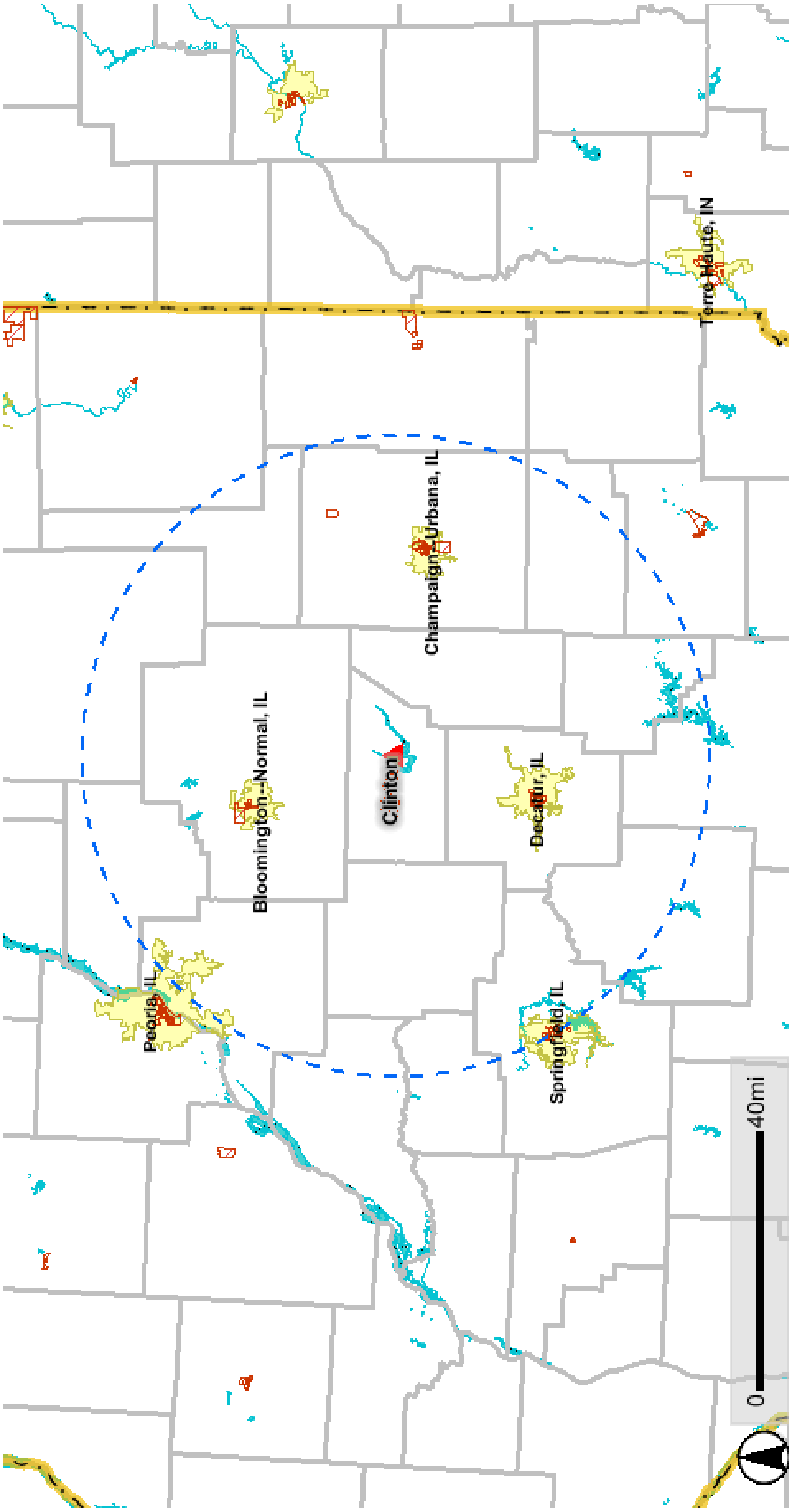

Figure 2-7. Locations of Low-Income Populations (shown in shaded areas) Within an 80-km (50-m) Radius of Exelon ESP Site

transmission-related studies by the Federal Energy Regulatory Commission or permitting actions by the Army Corps of Engineers. However, these activities do not relate to the ESP and have not been started. In summary, no other Federal activities or projects are associated with the permitting of this ESP site.

The geographic region covered by this EIS extends as far as Pontiac, Illinois, to the north. As such, the extreme northern portion of the region is overlapped by the regions of several other nuclear power stations, including Braidwood 1 and 2, Dresden 2 and 3, and LaSalle 1 and 2 (all considered possible alternative sites) and the CPS unit. As such, the 80-km (50-mi) region for the ESP site would encompass the communities in the area of Pontiac, Chattsworth, Fairbury, Forrest, and Chenoa, Illinois, as would several of the alternative ESP sites considered. These communities would be within the 80-km (50-mi) region of seven nuclear power stations if a new nuclear unit were constructed at the Exelon ESP site.

2.12 References

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10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, “Reactor Site Criteria.”

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, “Protection of Historic Properties.”

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 81, “Designation of Areas for Air Quality Planning Purposes.”

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3.0 Site Layout and Plant Parameter Envelope

The site for the proposed Exelon Generation Company, LLC (Exelon) early site permit (ESP) is located in DeWitt County in rural central Illinois, within the current Clinton Power Station (CPS) boundary. The site is situated approximately 10 km (6 mi) east of the City of Clinton, Illinois. This chapter describes the approach Exelon used to identify the key plant parameters and site characteristics that Exelon and the U.S. Nuclear Regulatory Commission (NRC) staff used to assess the environmental impacts of the proposed action. The site layout and existing facilities are discussed in Section 3.1. The plant parameters and power transmission system are discussed in Sections 3.2 and 3.3, respectively, and references for this chapter are in Section 3.4.

3.1 External Appearance and Plant Layout

The existing CPS site consists of one operating boiling water reactor manufactured by General Electric, a turbine building, a switchyard, intake and discharge structures, and support buildings. The site is located on the shore of Clinton Lake, an impoundment that was created in 1977 by erecting a dam on the arm of Salt Creek as a cooling source for the CPS. The existing unit uses Clinton Lake as an ultimate heat sink (UHS). A radioactive waste disposal system, a fuel-handling system, and the auxiliaries, structures, and other onsite facilities required for a complete nuclear power station exist on the CPS site. The existing CPS site development is shown in Figure 2-1. The existing CPS site would remain as is. The ESP site is located in a previously disturbed area adjacent to the existing unit.

A specific plant design has not been chosen for a new nuclear unit at the Exelon ESP site; instead, a set of bounding plant parameters known as a plant parameter envelope (PPE) has been specified to envelop the design to be considered for the ESP site. This PPE is based on the addition of a new nuclear unit, which would be a stand-alone plant with its own support systems. Exelon states that a new nuclear unit would share ancillary support structures, such as maintenance facilities, office centers, or waste- and water-treatment plants. A new nuclear unit may consist of one or more reactors or reactor modules. These multiple reactors or modules (the number of which may vary depending on the reactor type selected) would be grouped into one operating unit, and could have a total core thermal power rating between approximately 2400 and 6800 MW(t) (Exelon 2006a). For the purposes of the evaluation described in this environmental impact statement (EIS), the staff assumed a power rating of 6800 MW(t), unless stated otherwise. For the cooling system, Exelon has proposed either a wet cooling system that will utilize mechanical or natural draft cooling towers, or a hybrid wet/dry cooling system that will use a combination of the wet and dry systems. Exelon also states that a third option, use of a dry cooling system, is being proposed. However, the applicant states that full wet or hybrid wet/dry cooling processes have been assumed for most purposes because out of the options proposed, they have the greatest consumptive water uses. Exelon does not provide information on a dry cooling system to support an environmental analysis nor does the applicant address the adverse environmental impacts of such a system (noise, large footprint, and inefficiency). Therefore, the staff did not evaluate a dry cooling system during its review. Should Exelon choose to use a dry cooling system at the ESP site in a construction permit (CP) or a combined CP and operating license (combined license or COL) application, the staff will evaluate the environmental impacts of construction and operation of the system during that review.

3.2 Plant Parameter Envelope

As described in Subpart A of Title 10 of the Code of Federal Regulations (CFR) Part 52, the applicant for an ESP need not provide a detailed design of a reactor or reactors and the associated facilities but must provide sufficient bounding parameters and characteristics of the reactor or reactors and the associated facilities so that an assessment of site suitability can be made. Consequently, the ESP application may refer to a PPE as a surrogate for a nuclear power plant and its associated facilities.

A PPE is a set of values of plant design parameters that an ESP applicant expects will bound the design characteristics of the reactor or reactors that might be constructed at a given site. The PPE values are a surrogate for actual reactor design information. Analysis of environmental impacts based on a PPE approach permits an ESP applicant to defer the selection of a reactor design until the CP or COL stage. The PPE reflects upper or lower bounds (as appropriate) of the values for each parameter that it encompasses rather than the characteristics of any specific reactor design. Appendix J lists the complete set of PPE values that are provided in the Exelon ESP application.

Reactor Designs Considered in the PPE

In its ESP application, Exelon used a composite of values from seven reactor designs to develop the PPE (Exelon 2006a). The values used for the seven reactor designs are not necessarily the same values used in the safety evaluation. The values in this report are not design-specific; rather, they are used to determine the environmental impacts of a reactor design that falls within the values used in this report. The reactor designs used to develop the PPE include the following five light water reactors (LWRs) and two gas-cooled reactors:

- Advanced Canada Deuterium Uranium Reactor (ACR-700) – This reactor, developed by Atomic Energy Canada Limited, is an evolutionary extension of the CANDU 6 plant using very slightly enriched uranium fuel and light water coolant.

- Advanced Boiling Water Reactor (ABWR) – This reactor, developed by General Electric Company, is a standardized plant that has been certified under the NRC requirements in 10 CFR Part 52. The ABWR is fueled with slightly enriched uranium and uses a light water cooling system.

- Advanced Pressurized Water Reactor (AP1000) – This is an earlier version of the AP1000 reactor final design that was developed by Westinghouse Electric Company and subsequently approved by the NRC. The design uses slightly enriched uranium and a light water cooling system. Because the ESP environmental report (ER) was developed before the staff's review of the AP1000 was complete, this design is not the AP1000 that was certified under the NRC requirements in 10 CFR Part 52. It is an earlier version that is referred to as the "surrogate AP1000" throughout the rest of this report.

- Economic Simplified Boiling Water Reactor (ESBWR) – This reactor, developed by General Electric Company, is fueled with slightly enriched uranium and uses a light water cooling system.

- International Reactor Innovative and Secure (IRIS) next-generation pressurized water reactor (PWR) – This reactor is under development by a consortium led by Westinghouse Electric Company and is a modular light water reactor.

- Gas Turbine Modular Helium Reactor (GT-MHR) – This reactor, developed by General Atomics, is a modular helium-cooled graphite-moderated reactor.

- Pebble Bed Modular Reactor (PBMR) – This reactor, developed by PBMR (Pty) Ltd., is a modular graphite-moderated helium-cooled gas turbine reactor.

For illustration, power ratings and the number of reactors or modules identified as a potential single unit for the ESP site are listed in Table 3-1. The facility or unit that might be built on the ESP site might consist of one to eight reactors of the types listed in Table 3-1, or a combination of these different designs. Moreover, Exelon would not be required to use any of these designs if it elects to proceed with a CP or COL application; however, the applicant would have to demonstrate that the characteristics of the reactor(s) or reactor module(s) ultimately selected were within the bounds of the PPE for the assessment of a given characteristic contained in this EIS to be applicable.

Table 3-1. Power Ratings for Reactor Designs Considered in the PPE

	ABWR	ESBWR	AP1000	ACR-700	IRIS	GT-MHR	PBMR
Power rating per reactor or reactor module (MW(t))	3926 (4300)[(a)]	4000	3400	1983	1000	600	400
Number of reactors or reactor modules per unit	1	1	2	2	3	4	8
Power rating per unit (MW(t))	3926 (4300)[(a)]	4000	6800	3966	3000	2400	3200

(a) Exelon states that the site-related parameters for the ABWR are based on one 3926-MW(t) reactor. However, Exelon used parameters from an uprated 4300-MW(t) ABWR reactor in some of its analyses.

Other Considerations in the Review

Site-specific values were used to determine the atmospheric dispersion factors. Atmospheric dispersion factors were calculated using site meteorological conditions to determine the dilution capability of the site. At the CP or COL stage, the staff will need to verify that the atmospheric dispersion factors for the selected reactor are bounded by the values specified by the site atmospheric dispersion factors.

In its evaluation of uranium fuel cycle impacts for the Exelon ESP site, Exelon used the PPE approach for the advanced LWR designs but not for the two gas-cooled reactors. In its evaluation of the impacts from transportation of radioactive materials, Exelon did not use the PPE approach but rather evaluated each reactor design individually. In situations where designs were evaluated individually, Exelon would have to perform a new evaluation if a different design is proposed at the CP or COL stage. In its evaluation of the radiological consequences on the environment of potential design basis accidents, Exelon used the PPE approach focusing on two LWRs: the certified ABWR with a power level of 3926 MW(t) and a surrogate AP1000 reactor design with a power level of 3412 MW(t). The PPE does not include source terms for severe accidents; therefore, Exelon used source terms for the ABWR and the surrogate AP1000 reactors instead of PPE values. The staff did not evaluate the design basis or severe accident impacts for gas-cooled reactors. Therefore, at the CP or COL stage, Exelon and the staff will need to evaluate whether the environmental impacts of design basis and severe accidents at the Exelon ESP site remain bounded by the impacts from the surrogate (ABWR and AP1000) designs. The staff's evaluation of this analysis can be found in Section 5.10.

Review Approach

NUREG-1555, *Environmental Standard Review Plan* (ESRP) (NRC 2000), and review standard RS-002, *Processing Applications for Early Site Permits* (NRC 2004), provide guidance to the NRC staff to help ensure a thorough, consistent, and disciplined review of any ESP application.

The staff's June 23, 2003, responses to comments received on draft RS-002 (NRC 2003) provide additional insights on the staff's expectations and approach to the review of an application employing the PPE approach.

If PPE values are used as a surrogate for design-specific values, the staff expects Exelon to provide sufficient information for the staff to develop a reasonable independent assessment of potential impacts to specific environmental resources. In some cases, the design-specific information called for in the ESRP may not have been provided in the Exelon ESP application because it did not exist or was not available, so the NRC staff could not apply the ESRP guidance in these review areas. In these cases, the NRC staff used its experience and judgement to adapt the review guidance in the ESRP and to develop assumptions necessary to evaluate impacts to certain environmental resources to account for this missing information. These assumptions are discussed in the appropriate sections of the EIS.

Because the Exelon PPE values do not reflect a specific design, they were not reviewed by the NRC staff for correctness. However, the NRC staff made a determination that the application was sufficient to enable the staff to conduct its required environmental review and that the PPE values are not unreasonable for consideration by the staff when making its finding in accordance with Subpart A of 10 CFR Part 52. During its environmental review, the staff used its judgement to determine whether Exelon provided sufficient information for the staff to perform its independent assessment of the environmental impacts of construction and operation of a new nuclear unit. The staff considered the PPE values to be bounding parameters. Therefore, the staff's evaluation serves as a bounding estimate of the potential environmental impacts resulting from constructing and operating the new nuclear unit.

Throughout the ER (Exelon 2006b) supporting the Exelon ESP application, Exelon provides

(1) Commitments to address certain issues in the design, construction, and operation of the facility

(2) Statements of planned compliance with current laws, regulations, and requirements

(3) Commitments to future activities and actions that it will take should it decide to apply for a CP or COL

(4) Descriptions of Exelon's estimate of the environmental impacts resulting from the construction and operation of a new nuclear unit on the ESP site

(5) Descriptions of Exelon's estimates of future activities and actions of others and the likely environmental impacts of those activities and actions that would be expected should Exelon decide to apply for a CP or COL.

The activities described include, but are not limited to, such actions as:

- Considering the results of testing and monitoring during the development of the CP or COL application
- Complying with NRC and other agency regulations, including obtaining appropriate permits from other agencies
- Taking actions to mitigate adverse environmental impacts, including following industry or company standards, practices, or protocols
- Addressing certain issues at the CP or COL stage that were not addressed in the ESP application.

Some of these future actions are those that Exelon would be required to implement because they are currently required by law, and others are actions that Exelon has indicated that they will implement without the obligation of law to take such actions. Those matters considered by the staff in determining the level of impacts to a resource are discussed throughout this EIS and are listed in Appendix K.[(a)] Table K-1 lists those matters that were considered in the staff's evaluation of the environmental impacts related to the construction and operation of a new nuclear unit at the Exelon ESP site. Table K-2 lists those matters that are identified in the ER, but were not directly considered by the staff in its evaluation. Table K-3 lists statements related to activities and actions likely to be undertaken by others that were considered by the staff.

The staff performed its evaluation of the impacts of constructing and operating a new nuclear unit at the ESP site assuming that these commitments, activities, and actions would be undertaken by Exelon and others during future licensing activities.[(b)] As discussed previously, the staff developed assumptions necessary to evaluate impacts to certain environmental resources to account for missing detailed information. In addition to other sources of information obtained independently, the staff considered the commitments, future activities and actions, and estimates of expected environmental impacts that were identified by Exelon in its ER and listed in Appendix K, as well as the PPE values listed in Table J-1, when developing the inputs and assumptions used in the staff's own independent evaluation of the environmental impacts of constructing and operating a new unit on the Exelon ESP site.

(a) The listing is not intended to be a complete list of the commitments described in the ER.
(b) Those actions required to be undertaken by current law could change through the passage of future laws and regulations and, therefore, are listed in Appendix K to provide a listing of those laws and regulations considered during the staff's ESP environmental review.

In addition, as a result of the staff's environmental review of the Exelon ESP application, the staff determined that conditions or limitations on the ESP may be necessary in specific areas, as set forth in 10 CFR 52.24. Therefore, the staff identified when and how assumptions and bounding values limit its conclusion on the environmental impacts to a particular resource, where appropriate.

During the review of a CP or COL application referencing an ESP, the staff will assess the environmental impacts of the construction and operation of a specific plant design. If the environmental impacts addressed in an ESP EIS are found to be bounding by the staff, no additional analysis of these impacts will be required, even if the ESP applicant employed the PPE approach. However, environmental impacts not considered or not bounded at the ESP stage have to be assessed at the CP or COL stage. In addition, measures and controls to limit adverse impacts will need to be identified and evaluated for feasibility and adequacy in limiting adverse impacts at the CP or COL stage. The inputs and assumptions that were used or considered during the staff's evaluation of the ESP application (listed in Appendixes J and K) will provide the basis for the staff's verification review in which the staff must determine whether or not a specific design in a CP or COL application falls within the PPE, and the environmental impacts of the construction and operation of that specific design fall within the bounds of environmental impacts estimated by the staff at the ESP stage.

3.2.1 Plant Water Use

The PPE provides bounding constraints on portions of the ESP unit water use. Other constraints on plant water use are based on site-specific information. This EIS assesses the impacts of plant water use bounded by the PPE and site-specific constraints. The following sections describe both the consumptive and nonconsumptive water uses of the proposed ESP unit and the associated plant water-treatment systems. The cooling systems are described in more detail in Section 3.2.2.

3.2.1.1 Plant Water Consumption

The primary water demand for the proposed ESP unit is for condenser cooling. Exelon discusses using either a wet tower closed-loop cooling system or a hybrid wet/dry closed-loop cooling system. The PPE provides bounds for a wet tower cooling system but no similar values for the hybrid wet/dry cooling system. The staff assumed that water use for the hybrid wet/dry cooling system is bounded by the wet cooling system values. Therefore, the following discussion is limited to the wet tower system. The hybrid wet/dry cooling system will not be addressed further in this EIS.

The current CPS relies on once-through cooling. The original environmental analysis for the CPS found that Clinton Lake was expected to be able to support two once-through cooling units. In its ER, however, Exelon proposed that a closed-cycle cooling tower be used with the new nuclear unit (Exelon 2006b). While the nonconsumptive water use of a closed-cycle tower is far less than a once-through cooling system, the consumptive water use is greater. For a wet tower, the majority of water withdrawn from Clinton Lake would be lost to the atmosphere as evaporation. To prevent the concentration of solids and dissolved solids from increasing to a level that would impair the functioning of the cooling tower, a fraction of the water in the tower is continuously released as blowdown. By contrast, a once-through system returns the same amount of water as it withdraws; however, the elevated temperature returned to Clinton Lake from a once-through cooling system does result in some induced evaporation from the lake to the environment.

A new nuclear unit would normally withdraw 2829 L/s (44,843 gpm) through the intake structure. Blowdown from the normal heat sink cooling tower(s) would return approximately 760 L/s (12,000 gpm) as blowdown to Clinton Lake via the discharge flume.

A new nuclear unit would also have demands for potable water, demineralized water, filtered water, and fire protection water. In Table 3.3-2 of its ER, Exelon estimates these combined consumptive water uses would be 49.1 L/s (778 gpm) under normal conditions and 226.7 L/s (3593 gpm) when demands are at maximum levels (including filling the fire protection system to full capacity) (Exelon 2006a). Blowdown from the UHS towers is expected to return normal flow rate of 9.1 L/s (144 gpm) (44 L/s [700 gpm] maximum) to the lake via the discharge flume (Exelon 2006b).

For safety-related cooling, the UHS for a new nuclear unit would provide cooling water to reactor cooling systems and safety-related components. Exelon proposes to use the same UHS reservoir as the CPS uses for its UHS reservoir, which was designed to accommodate two units. The UHS reservoir will provide makeup water to mechanical draft UHS towers.

3.2.1.2 Plant Water Treatment

Because a specific design has not been selected, the water-treatment system for the ESP unit is not specified. Details and limits of the plant water-treatment system will be provided in the CP or COL application. The water quality of effluents from any water treatment would be regulated by the new nuclear unit's National Pollutant Discharge Elimination System (NPDES) permit.

3.2.2 Cooling System

In Sections 3.4.1 and 3.4.2 of its ER, Exelon describes the operational modes and components, respectively, for the cooling systems for a new nuclear unit (Exelon 2006b). While the design of the cooling system has not been specified, parameters from the PPE are used to bound the impacts of the cooling system on the environment. The specific details and limits of the cooling system will be provided in the CP or COL application.

3.2.2.1 Description and Operational Modes

The following sections describe the operating modes under normal operating conditions and emergency/shutdown conditions for a new nuclear unit at the Exelon ESP site using wet-tower closed-cycle cooling.

Normal Cooling

During normal operation at full power, based on the PPE, the cooling tower system is required to reject a heat load of 4420 MW (15.1 x 10^9 Btu/hr) to the environment. The new unit will reject this heat load using cooling towers. Based on the PPE, the maximum blowdown temperature is 38.3°C (101°F).

During low-water conditions, the existing CPS unit is allowed to operate down to a lake-level elevation of 206 m (677 ft) above mean sea level. Exelon is proposing that the new nuclear unit also be allowed to operate down to 206 m (677 ft) above mean sea level (Exelon 2006a).

Ultimate Heat Sink

Based on the PPE, during shutdown, the UHS system would reject 121 MW (411.4 x 10^6 Btu/hr) to the environment. Makeup water for the mechanical draft UHS cooling towers is withdrawn from the UHS reservoir. The reservoir is required to maintain an adequate supply of water for 30 days of emergency operation. Based on the PPE, the maximum blowdown discharged to the discharge canal is 44 L/s (700 gpm).

3.2.2.2 Component Descriptions

The following sections describe the intake, discharge, and heat-dissipation systems. Pursuant to the 316(a) and 316(b) provisions of the Clean Water Act (33 USC 1251), prior to any construction activities, Exelon will be required to obtain approval from the Illinois Environmental Protection Agency (IEPA) by documenting plant design and site-specific analyses regarding the impacts of the thermal discharges and intake systems on the Clinton Lake aquatic environment.

Intake System

The proposed location of the intake structure is shown on Figure 2-1 (Exelon 2006b). The location of the intake would be approximately 20 m (65 ft) south of the location of the CPS intake structure. The intakes for both the normal heat sink and UHS of a new nuclear unit would be at the same location. Trash racks and traveling screens (or similar facilities) would be used to prevent debris from entering the intake pumps. The approach velocity to the intake would be limited to no more than 0.15 m/s (0.5 ft/s).

Discharge System

The proposed location of the discharge structure for a new nuclear unit is shown in Figure 2.1 (Exelon 2006b). The cooling tower blowdown and other discharges would enter the discharge flume near the location of the CPS discharge.

Heat Dissipation Systems

No specific design information on the normal heat dissipation systems was provided in the Exelon ESP application. While a cooling tower system bounded by the PPE is required to reject 4420 MW (15.1 x 10^9 Btu/hr) to the environment, the exact design is unknown. To meet UHS needs, Exelon proposed mechanical draft UHS cooling towers with makeup water withdrawn from the UHS reservoir. The UHS reservoir is a submerged pond within the North Fork arm of Clinton Lake formed by a submerged dam. The UHS reservoir also provides the heat sink for the emergency cooling system of the existing CPS unit.

3.2.3 Radioactive Waste Management System

Liquid, gaseous, and solid radioactive waste-management systems would be used to collect and treat the radioactive materials that are produced as a by-product of operating the proposed nuclear unit on the Exelon ESP site. These systems would process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as reasonably achievable before releasing them to the environment. Waste-processing systems would be designed to meet the design objectives of 10 CFR Part 50, Appendix I ("Numerical Guide for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radiological Material in Light Water-Cooled Nuclear Power Reactor Effluents"). Radioactive material in the reactor coolant would be the primary source of gaseous, liquid, and solid radioactive wastes in LWRs. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products would be contained in the sealed fuel rods, but small quantities escape the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system would also be responsible for coolant contamination.

Exelon did not identify specific radioactive waste-management systems for a new nuclear unit on the ESP site. The PPE concept was used to provide an upper bound on liquid radioactive effluents, gaseous radioactive effluents, and solid radioactive waste releases (Exelon 2006a). Bounding effluent concentrations were determined, based on a composite of the highest activity content of the individual isotopes from two surrogate AP1000 reactors (6800 MW(t)), three IRIS reactors (3000 MW(t)), one ABWR reactor (3926 MW(t)), one ESBWR reactor (4000 MW(t)), two ACR-700 reactors (3966 MW(t)), four GT-MHR modules (2400 MW(t)), and eight PBMR modules (3200 MW(t)). Bounding liquid effluent releases are found in Table 3.5-1 of the ER (Exelon 2006b). Bounding gaseous effluent releases are found in Table 3.5-3 and bounding solid waste activities in Table 3.5-5 of the ER (Exelon 2006b). The bounding total annual volume of solid radioactive waste is estimated at 427.2 m^3/yr (15,087 ft^3/yr) with a bounding total amount of radioactive material activity of 2.2 x 10^{14} Bq (5900 Ci/yr), as found in the Site Safety Analysis Report in the application for the ESP (Exelon 2006a).

3.2.4 Nonradioactive Waste Systems

The following sections provide descriptions of the nonradioactive waste systems for a new nuclear unit at the ESP site, including systems for chemical, biocide, and sanitary effluents, as well as other effluents.

3.2.4.1 Effluents Containing Chemicals or Biocides

In the PPE approach, specific quantities and concentrations of chemicals or biocides used for proper water chemistry in the reactors are not identified. Exelon identified principal chemical, biocide, and pollutant sources that may be produced during operations, including sodium hydroxide and sulfuric acid (to regenerate resins), phosphate in cleaning solutions, biocides used for condenser defouling, boiler blowdown chemicals, oil and grease from plant floor drains, chloride, sulphates, copper, iron, and zinc (Exelon 2006b). These chemicals would be discharged to the environment through treatment of domestic water, circulation water, and plant blowdown. Exelon (2006b) states that the approved NPDES permit for the ESP site issued by the IEPA will limit the volume and concentration of these discharges. The combined effluents of the CPS and ESP units would remain within the bounds of the existing CPS unit's NPDES permit issued by IEPA.

Table 3.6-1 of the ER (Exelon 2006b) provides bounding concentrations of impurities in the blowdown water. Small volumes of waste water from other station systems will be combined with cooling water discharges. EPA's blowdown effluent guidelines (40 CFR Part 423) would regulate the chemistry of blowdown water.

3.2.4.2 Sanitary System Effluents

Sanitary systems during pre-construction and construction activities will include the use of portable toilets. During operation, sanitary system wastes will likely be handled through the existing CPS sanitary sewage treatment plant. Discharges from this plant will be controlled in accordance with an approved NPDES permit issued by the IEPA. Based on the PPE, the normal sanitary discharge rate is 3.8 L/s (60 gpm) and the maximum discharge rate is 12.5 L/s (198 gpm).

3.2.4.3 Other Effluents

Discharges from the chemical waste-treatment system, plant drains, and storm drainage will go into Clinton Lake. The bounding liquid effluent discharges are 20.4 L/s (323 gpm) for normal operation and 29.7 L/s (470 gpm) maximum. Exelon indicated that the design of the plant storm water drainage systems will be presented at the CP or COL stage.

In the PPE, Exelon has identified bounding estimates for the total quantity of sulfur oxides (SO_x), nitrogen oxides (NO_x), hydrocarbons, and suspended particulates to be discharged annually during station operations by diesel engines, gas turbines, and heating facilities. The bounding annual pollutant amounts are provided in Tables 3.6-4 and 3.6-5 of the ER (Exelon 2006b) for auxiliary boilers, standby generators, and standby power system gas turbine flue gas.

3.3 Power Transmission System

The proposed ESP site is adjacent to the CPS, which is owned and operated by AmerGen within the service area of the Illinois Power Company (the regional electrical transmission system owner/operator). The primary electrical transmission system in central Illinois operates at 345 kV with secondary systems operating at 138 kV. The CPS connects to the AmerenIP transmission system at the CPS 345-kV switch station. From the CPS switch station, the AmerenIP has 345-kV interconnections to the Brokaw, Oreana, Rising, and Latham substations.

The existing transmission system from the CPS switch station has excess capacity and could handle a portion, but not all, of the power generated by a new nuclear unit. To the extent that additional transmission lines would be required to transmit power from the site, Exelon considers it most likely that the interconnections would be at the junction point of the CPS-Oreana line with the Latham-Rising line, about 5 km (3 mi) east of the town of Maroa (Exelon 2006b). According to the ER, four new transmission lines would be required. Two parallel, double-circuit lines would run north approximately 37 km (23 mi) to the Brokaw substation near Bloomington, and two parallel, double-circuit lines would run south-southwest approximately 19 km (12 mi) to the junction of the CPS-Oreana line and the Latham-Rising line (Exelon 2006b).

According to the ER, the existing transmission line rights-of-way between the CPS and the Brokaw and Oreana substations are generally 40 m (130 ft) wide. If past Illinois Power Company practices were to be followed, these rights-of-way would have to be widened to 76 m (250 ft) to accommodate a pair of parallel lines. Use of more typical designs for steel-lattice structures or monopoles could reduce the rights-of-way requirement to about 49 m (160 ft). However, in any case, it is likely that securing additional rights-of-way would be required. Land use in the existing rights-of-way is discussed in Section 2.2.2 of this report. Land-use impacts of construction of additional transmission lines along the existing rights-of-way and in the general area are discussed in Section 4.1.2, and land use impacts associated with operation of new lines are discussed in Section 5.1.2.

Exelon has not submitted an interconnection request to AmerenIP. The following paragraphs describe the process for requesting connection to the transmission system that Exelon would be required to follow should it decide to build a new nuclear unit at the ESP site. It is expected that the process for obtaining transmission services would be completed before submission of an application for construction and operation of a new nuclear unit.

Procedures for requesting connection to the transmission line rights-of-way system are set forth by the Federal Energy Regulatory Commission (FERC) in 18 CFR Part 35 and by the State of Illinois in the AmerenIP Open Access Transmission Tariff. The FERC process starts when an interconnection customer, in this case Exelon, submits an interconnection request to the transmission provider (AmerenIP). When the interconnection request is determined to be valid, the transmission provider and interconnection customer have a meeting to discuss alternative interconnection options and exchange information. On the basis of this meeting, the interconnection customer designates its point of interconnection and one or more alternative points of interconnection.

Following the scoping meeting, the transmission provider conducts an Interconnection Feasibility Study to preliminarily evaluate the feasibility of the proposed interconnection to the transmission line system. This study includes a power flow and short-circuit analysis. The Interconnection Feasibility Study is followed by an Interconnection System Impact Study that focuses on the impact of the interconnection on the reliability of the transmission line system. Finally, the transmission provider conducts an Interconnection Facilities Study to specify and estimate the cost of the equipment, engineering, procurement, and construction work needed to implement the conclusions of the Interconnection System Impact Study, in accordance with good utility practice, to physically and electrically connect the interconnection facility to the transmission line system. The cost of these studies, which are conducted by the transmission line provider, are borne by the interconnection customer.

3.4 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

18 CFR Part 35. Code of Federal Regulations, Title 18, *Conservation of Power and Water Resources*, Part 35, "Filing of Rate Schedules and Tariffs."

40 CFR Part 423. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 423, "Steam Electric Power Generating Point Source Category."

Clean Water Act (CWA). 33 USC 1251, et seq. (also referred to as the Federal Water Pollution Control Act).

Exelon Generation Company, LLC (Exelon). 2006a. *Exelon Generation Company, LLC, Early Site Permit Application: Site Safety Analysis Report, Rev. 4*. Exelon Nuclear, Kennett Square, Pennsylvania.

Exelon Generation Company, LLC (Exelon). 2006b. *Exelon Generation Company, LLC, Early Site Permit Application: Environmental Report, Rev. 4*. Exelon Nuclear, Kennett Square, Pennsylvania.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan (ESRP)*. NUREG-1555, Vol. 1, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2003. Letter from J.L. Lyons, Office of Nuclear Reactor Regulation, NRC, to R.L. Simard, Nuclear Energy Institute, dated June 23, 2003, U.S. Nuclear Regulatory Commission Responses to Nuclear Energy Institute (NEI) Comments on Draft RS-002, Processing Applications for Early Site Permits (ML031710698).

U.S. Nuclear Regulatory Commission (NRC). 2004. *Processing Applications for Early Site Permits.* RS-002, NRC, Washington, D.C.

4.0 Construction Impacts at the Proposed Site

This chapter examines the environmental issues associated with the potential site-preparation activities and construction of the proposed new nuclear unit adjacent to the Clinton Power Station (CPS) as described in the application for an early site permit (ESP) submitted by Exelon Generation Company, LLC (Exelon). As part of this application, Exelon submitted an Environmental Report (ER) and a site redress plan (Exelon 2006a). The ER provides the plant parameter envelope (PPE) as the basis for the environmental review. The parameters included in the PPE and their values are listed in Appendix J. The site redress plan allows for specific site-preparation activities to be conducted with approval of an ESP. The activities evaluated for the Exelon ESP site are those permitted by Title 10 of the Code of Federal Regulations (CFR), 50.10(e)(1) and 52.25(a). In the event that the ESP is approved and Exelon conducts site-preparation activities but does not build the new nuclear unit, Exelon would be required to implement its site redress plan.

In Sections 4.1 through 4.9, the staff evaluates the potential impacts on land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, and applicable measures and controls that would limit the adverse impacts of station construction. In accordance with 10 CFR Part 51, impacts have been analyzed, and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned to each analysis. In the area of socioeconomics, related to taxes, the impacts may be considered beneficial and are stated as such. Possible mitigation of adverse impacts, where appropriate, is presented in Section 4.10, followed by a description of the site redress plan in Section 4.11. A summary of the construction impacts is presented in Section 4.12. Full citations for the references cited in this chapter are listed in Section 4.13. Cumulative impacts of construction and operation are discussed in Chapter 7. The technical analyses provided in this chapter support the results, conclusions, and recommendations presented in Chapters 9 and 10.

The staff relied on the mitigation measures and the required Federal, State, and local permits and authorizations presented in the ER in reaching its conclusion on the significance level of the adverse impacts. The staff relied on the infrastructure upgrades planned by the counties, cities, and towns, in assigning significance levels to the impacts. Failure to implement such infrastructure upgrades may result in larger impact levels.

4.1 Land-Use Impacts

This section provides information regarding land-use impacts associated with site-preparation activities and construction of a proposed new nuclear unit at the Exelon ESP site. Topics discussed include land-use impacts at the site and in the vicinity of the site, land-use impacts in transmission line rights-of-way and offsite areas, and impacts on historic and cultural resources.

4.1.1 The Site and Vicinity

The ESP site is located entirely within the existing CPS site, which is zoned for transportation and industrial use by DeWitt County.

The granting of an ESP to Exelon would permit many preconstruction activities under 10 CFR 50.10 that may result in impacts to land use. At the discretion of the ESP holder, Exelon indicates in its Site Redress Plan that some, none, or all of the following activities may be carried out prior to construction of a new nuclear unit at the Exelon ESP site (Exelon 2006b):

- Preparation of the site for construction of the facility (including such activities as clearing, grading, construction of temporary access roads, and borrow areas) as allowed by 10 CFR 50.10(e)(1)(i)

- Installation of temporary construction support facilities (including items such as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings) as allowed by 10 CFR 50.10(e)(1)(ii)

- Excavation for facility structures as allowed by 10 CFR 50.10(e)(1)(ii)

- Construction of service facilities (including facilities such as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, transmission lines, and sanitary sewerage treatment facilities as allowed by 10 CFR 50.10(e)(1)(iv)

- Drilling sample/monitoring wells or additional geophysical borings as allowed by 10 CFR 50.10(e)(1)(v)

- Construction of plant cooling tower structures that are not safety-related as allowed by 10 CFR 50.10(e)(1)(v)

- Construction of plant intake structures that are not safety-related as allowed by 10 CFR 50.10(e)(1)(v)

- Installation of non-safety-related fire detection and protection equipment as allowed by 10 CFR 50.10(e)(1)(v)

- Expansion of the existing CPS switchyard to accommodate the construction of the proposed ESP facility

- Expansion of the CPS transmission system

- Modification of the existing CPS discharge flume, as necessary, to accommodate the ESP facility outflow

- Construction of any other additional structures, systems, and components, which do not prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public.

These activities would be accomplished using best construction practices and would follow all applicable laws and regulations (Exelon 2006a). Similar activities were undertaken for the original CPS construction utilizing the ESP site, and would be expected to be contained within the footprint of previously disturbed areas in preparation for construction of a new nuclear unit at the Exelon ESP site.

All construction activities for a new nuclear unit, including ground-disturbing activities, would occur within the Exelon ESP site boundary. The area that would be affected on a long-term basis as a result of permanent facilities is approximately 39 ha (96 ac) (Exelon 2006a). Additional areas within the existing CPS site would be disturbed on a short-term basis as a result of temporary activities, facilities, and laydown areas.

No new or modified highways or railroad lines are planned to support a new nuclear unit (Exelon 2006a). Clearing and removal of trees growing within the ESP site would be required. No agricultural lands would be directly affected by construction activities.

A few small wetland areas exist on the ESP site. Exelon intends to avoid wetlands to the extent possible during any construction (Exelon 2006a). Any work that has the potential to impact a wetland would be performed in accordance with applicable regulatory requirements.

Any work conducted immediately adjacent to the Clinton Lake Recreation Area would be performed in accordance with applicable Federal, State, and local laws and regulations, permits, and authorizations. Therefore, construction-related impacts would not affect the recreational uses of Clinton Lake or other areas in the vicinity (Exelon 2006a). See Section 4.4 for potential ecological impacts and Section 4.5.1 for physical impacts associated with a new nuclear unit.

Construction of a new nuclear unit at the Exelon ESP site and its associated intake structure would not cause any alteration in flood levels because no facilities would be constructed in the post-construction flood-prone area. Therefore, no construction-related impacts would be expected to affect current land uses within floodplains.

Offsite land-use changes as a result of construction activities are expected to be minimal. The majority of the construction workforce would be expected to commute from other communities, and, therefore, little impact in terms of new housing construction would be expected in the vicinity of the ESP site.

The staff reviewed the available information on the land-use impacts of constructing a new nuclear unit at the CPS site. Based on this review, the staff concludes that there are no land-use impacts that would render the site unsuitable for a new nuclear unit. Therefore, the staff concludes that the environmental impact resulting from land use would be SMALL, and mitigation would not be warranted.

4.1.2 Transmission Line Rights-of-Way and Offsite Areas

In its ER, Exelon states that construction of a new nuclear unit at the Exelon ESP site would require interconnection to an upgraded transmission system, and hypothesized that existing transmission lines running north and south from the ESP site would be expanded (Exelon 2006a). If the new unit at the Exelon ESP site is constructed, the actual need for and type of transmission system improvements would be determined by the transmission and distribution system owner and operator (currently AmerenIP) under provisions of 18 CFR Part 35. In general, the process is designed to determine the optimal routing of new transmission service by performing feasibility, impact, and facilities studies associated with the transmission interconnection request. This process is discussed in Section 3.3. The staff assumed that once the transmission routing is determined, if required, State or local agencies governing the actual siting of transmission facilities would be consulted.

Upgrading the existing transmission system would be necessary to accommodate the full generating capacity of a new nuclear unit at the ESP site. To accomplish this upgrade, one or more new rights-of-way could be needed, or all upgrades could be sited within the existing rights-of-way with no right-of-way expansion necessary. The addition of new support structures and transmission lines and vegetation clearing would be required. Based on values in Table 2-1, the staff estimated that the land-use impact of doubling the width of the rights-of-way or a new routing would include conversion of as much as 25 ha (61 ac) of currently undeveloped forested land to vegetation-managed land along the widened portions of the rights-of-way. The staff assumed that the vegetation-clearing activities would involve logging of existing forested land bordering the existing rights-of-way. Although noticeable, this impact is not expected to be significant nor to noticeably alter significant existing land uses because the existing rights-of-way traverse land in active agricultural production. Minimal plots of land would be removed from agricultural production where new transmission towers would be sited. In their ER, Exelon states that any land-clearing or construction activities in the existing rights-of-way would follow best management practices and would be mitigated to the extent possible.

The likely pathway of any new transmission lines required to deliver power from a new unit at the ESP site almost exclusively would cross land currently in seasonal agricultural production, whether the existing rights-of-way are doubled or new rights-of-way are used. The principal impacts from construction activities would be minimal and mostly temporary and would alter the land use on a relatively minimal amount of land. Given the information provided in the applicant's ER and the staff's independent review, construction-related impacts on land use in the transmission line rights-of-way that require upgrading and offsite areas would be SMALL and additional mitigation beyond what Exelon has indicated is not warranted.

4.2 Meteorological and Air Quality Impacts

Sections 2.3.1 and 2.3.2 describe the meteorological characteristics and air quality of the Exelon ESP site. The primary impacts of construction of a new nuclear unit at the Exelon ESP site on local meteorology and air quality would be from dust from construction activities, open burning, emissions from equipment and machinery used in construction, concrete batch plant operations, and emissions from vehicles used to transport workers and materials to and from the site.

4.2.1 Construction Activities

Activities associated with construction of a new nuclear unit would be similar to the activities associated with construction of any large structure. There would be ground-clearing, grading, excavation, and movement of materials and machinery. Ground-clearing, grading, and excavation activities would raise dust, and fugitive dust would be raised by the movement of materials and machinery. Fugitive dust might also rise from cleared areas during windy periods.

A State air permit is not required for dust generated by construction activities (35 IAC 201.146(tt)). However, Exelon stated in its ER (Exelon 2006a) that dust from construction activities would be mitigated to the extent possible. In addition, Exelon stated that applicable air quality regulations would be adhered to as they apply to open burning and fuel-burning equipment.

The ER (Exelon 2006a) lists several measures that would be taken to mitigate air emissions from construction sources, including wetting during dry periods, seeding of bare areas, paving the most traveled construction roads, obtaining permits and certificates for construction equipment and activities, maintaining fuel-burning equipment in good condition, and equipping concrete facilities with dust-control systems.

Construction activities take place for a limited duration and can be controlled using standard measures. Impacts on meteorology and air quality that might occur would be temporary and limited in magnitude. Therefore, the staff concludes that the impacts from construction activities at the Exelon ESP site would be SMALL, and mitigation would not be warranted.

4.2.2 Transportation

Exelon estimates that construction activities would generate approximately 3300 additional car and truck trips daily on Illinois State Routes (SRs) 10 and 54 (Exelon 2006a). Exhaust from these vehicles will decrease air quality somewhat, but it is unlikely that air quality would be degraded sufficiently to be noticeable beyond the immediate vicinity of these highways. The effects of vehicle exhaust from 2300 cars (4600 trips per day) were considered in NUREG-1437 (NRC 1996) and found to be of potential concern if the trips were made in an area where air quality was out of compliance with the National Ambient Air Quality Standards. Air quality in DeWitt County and the surrounding counties is in compliance with all standards. Therefore, the staff concludes that the impact on air quality of increased traffic associated with construction at the Exelon ESP site would be SMALL, and additional mitigation would not be warranted.

4.3 Water-Related Impacts

Water-related impacts involved in the construction of a nuclear unit are similar to impacts that would be associated with any large industrial construction project. Likewise, Exelon must secure the same permits and follow the same construction best management practices as any other builder of a large industrial facility. Before initiating construction, Exelon is required to obtain permits regulating alterations to the hydrologic environment. These permits may include:

- Clean Water Act (CWA) Section 404 permit. This permit would be issued by the U.S. Army Corps of Engineers (ACE) and regulate impacts of construction activities on wetlands and management of dredged material.

- CWA Section 401 certification. This certification would be issued by the State of Illinois and ensure that projects do not conflict with State water quality management programs.

- CWA Section 402(p) National Pollutant Discharge Elimination System (NPDES) storm water permit. This permit would be issued by the Illinois Environmental Protection

Agency (IEPA) and regulates point-source storm water discharges. The U.S. Environmental Protection Agency's (EPA) 1990 Phase 1 Storm Water Regulation (see EPA 2004) established requirements for storm water discharges, listing various activities including construction activities disturbing an area of at least 2.0 ha (5.0 ac). The EPA has delegated the responsibility for administering the NPDES program in Illinois to the IEPA.

4.3.1 Hydrological Alterations

According to the National Wetland Inventory database, there are four minor herbaceous wetlands (less than 0.4 ha [1 ac]) within the Exelon ESP site boundary. These wetlands do not occur within the power block, cooling tower, switchyard expansion, or new intake footprint areas and, therefore, are not anticipated to be impacted by construction of these structures (Exelon 2006a). However, the locations of associated equipment laydown and fill disposal areas and the conduit for the new intake are currently unknown and could, thus, impact these wetlands, depending on their ultimate locations. Exelon plans to site these areas so as to preclude impacts to the wetlands (Exelon 2006a).

The descriptions of wetlands in the National Wetland Inventory database are based on interpretation of visible geography, vegetation, and hydrology in high altitude aerial photos. As such, the aerial extent and characteristics of these wetlands are not considered to be sufficiently accurate to be used as a baseline for potential construction impacts. Consequently, delineations and jurisdictional determinations of the upland wetlands, and any submerged lake areas, that could be impacted by construction have not yet been made. Exelon would have to submit an application for a 404 permit to the ACE that would address these areas before undertaking any construction activities. The ACE's permitting process ensures that impacts of construction are limited by requiring the appropriate construction best management practices.

The ACE would require that Exelon obtain a certification that is required pursuant to Section 401 of the Federal Water Pollution Control Act (FWPCA) before issuing a 404 permit. Exelon currently has not obtained a 401 certification from the State of Illinois for construction activities on the ESP site. The applicant indicated that because the purpose of the ER is only to establish the feasibility of the proposed location, it would not apply for such permits until the COL phase (Exelon 2006a). In its letter dated October 11, 2005, the staff asked Exelon for the status of activities related to the 401 certification. The staff was concerned that some of the site preparation and limited construction activities that would be authorized pursuant to 10 CFR 52.25(a) and 50.10(e)(1), if the ESP were issued, would require, among other approvals, a Section 401 certification or a waiver of that certification. In addition, the staff is aware of the requirement in Section 401 of the FWPCA that "No license or permit shall be granted until the certification required by this section has been obtained or has been waived ..." (CWA, 33 USC 1251).

As a result of this issue, Exelon began discussions with the Illinois Environmental Protection Agency (IEPA), the state agency responsible for enforcing the requirements of Section 401 of the FWCPA in Illinois. As a result of these discussions, Exelon proposed to the IEPA that the following permit condition be included in the ESP, should it be issued, in order to meet the intent of the FWPCA and ensure compliance with that statute (NRC 2006):

> The Permit Holder is prohibited from conducting any activity authorized by this Permit without first submitting to the NRC:
>
> (a) a copy of a 401 certification (which constitutes the certification required under FWPCA § 401), issued by the Illinois Environmental Protection Agency (IEPA) under 35 Illinois Administrative Code Part 395, or
>
> (b) its determination that no 401 certification is required.
>
> The Permit Holder shall submit to the IEPA annually (with a copy to the NRC) or some other mutually agreed upon periodicity, an advisory letter regarding any activities it expects to conduct under this Permit for the following period (e.g., 1 year), including a determination of whether such activities require a 401 certification. For those site preparation or limited construction activities which the Permit Holder has determined do not require a 401 certification, the Permit Holder is prohibited from conducting those activities for 30 days of the date of the advisory letter unless it receives a formal written response from the IEPA. No such notification is required if no work is expected to be performed under this Permit for the designated period.

Should the IEPA determine that this permit condition is an appropriate approach for complying with the intent of the FWPCA and ensuring compliance with that statute, any ESP that the staff might issue would include the permit condition.

Many of the possible reactor designs covered in the PPE would require that dewatering systems be installed during construction of the foundation of the reactor and various other buildings. Dewatering systems would depress the water table in the local vicinity and possibly change the direction of groundwater flow and the available capacity of local wells. These impacts would be temporary. The staff therefore concludes that impacts of hydrologic alterations due to construction activities would be localized and temporary. The IEPA 401 and ACE 404 permit process would be adequate to ensure that impacts of hydrologic alterations are SMALL.

4.3.2 Water-Use Impacts

Water-use requirements for construction activities are similar to other large industrial construction projects. Additional potable water supplies for the construction workforce would be required. Dewatering systems that are active during excavation and construction would result in a decline in the local water table. Water for various standard construction activities, such as dust abatement, would be required. The staff assumed that water use during construction would be less than 10 percent of the consumptive water loss from the wet towers at a new nuclear unit. The staff therefore concludes that water-use impacts due to construction activities would be SMALL, localized, and temporary.

4.3.3 Water Quality Impacts

Water quality impacts for the construction activities are similar to those for other large industrial construction projects. Once Exelon has established formal construction plans, a CWA Section 402(p) NPDES storm water permit from IEPA would be required before any construction activities could commence at the site. Construction best-management practices would ensure that accidental spills and storm water runoff will have minimal impact on the lake and surrounding areas. Due to the low water velocities within the lake, sediment discharge to the lake during construction would likely settle out in the lake and not result in downstream impacts. The staff, therefore, concludes that water quality impacts due to construction activities would be SMALL, localized, and temporary.

4.4 Ecological Impacts

This section describes the potential impacts to ecological resources from construction of a new nuclear unit at the Exelon ESP site and anticipated transmission system upgrades for the new unit. The section is divided into three subsections: terrestrial impacts, aquatic impacts, and impacts to threatened and endangered species.

4.4.1 Terrestrial Impacts

The staff considered impacts on habitat, wildlife, and State-listed species during the construction of a new nuclear unit at the Exelon ESP site. However, certain details of construction activities at the Exelon ESP site are not known at this time. Consequently, the staff's analysis was not performed to the depth warranted for actual construction. It is, however, sufficient for the purpose of comparing the proposed action to the alternatives.

4.4.1.1 Habitat

A total of 187 ha (461 ac) is located within the Exelon ESP site (Exelon 2006a). All of the ESP site has been graded or otherwise developed for operation of the existing CPS (Exelon 2006a).

Most of the footprint of the new nuclear unit at the ESP site consists of areas that would be occupied by the power block structures, normal heat sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers. The anticipated footprint of these structures is provided in Figure 4-1. Existing access roads and infrastructure (see Chapter 2, Figure 2-1) would primarily be used for construction of the new nuclear unit. Construction would disturb up to approximately 38 ha (93 ac), comprising permanent facilities and equipment laydown areas, most of which would occur about 213 m (700 ft) south of the existing CPS (Figure 4-1) (Exelon 2006a).

Construction of a new nuclear unit would occur primarily in previously disturbed areas (e.g., impervious surfaces, crushed stone, existing structures, etc.), and in open fields (e.g., previously used as equipment laydown areas during construction of the CPS, etc.) (Exelon 2006a). However, two small forest stands of about 1.2 ha (3 ac) and about 0.2 ha (0.5 ac) in the northern corner of the power-block footprint and within the new intake footprint (see Figure 4-1), respectively, would be cleared. Consequently, a loss of a total of 1.4 ha (3.5 ac) of forest habitat onsite is anticipated. Because these are small stands of young regenerating forest (by virtue of the fact that the entire ESP site was disturbed for construction of the existing CPS) that do not support any important species (as defined in NRC 2000), their loss is considered minor.

Construction of a new nuclear unit at the ESP site would not be anticipated to adversely affect wetlands onsite. The four minor wetlands (less than 0.4 ha [1 ac]) listed in the National Wetlands Inventory database do not occur within the power block, cooling tower, switchyard expansion, or new intake footprint areas and, therefore, would not be impacted by construction of these structures (Exelon 2006a). The locations of associated equipment laydown and fill disposal areas and the conduit for the new intake are currently unknown; however, they would not be anticipated to adversely affect wetlands and associated forest habitat onsite. Exelon would site these so as to preclude impacts to these wetlands (Exelon 2006a).

The descriptions of wetlands in the National Wetland Inventory database are based on interpretation of visible geography, vegetation, and hydrology in high altitude aerial photos. As such, the aerial extent and characteristics of these wetlands are not considered to be sufficiently accurate to be used as a baseline for potential construction impacts. Consequently, delineations and jurisdictional determinations of the wetlands that could be impacted by construction have not yet been determined. An applicant referencing the Exelon ESP in an application for a CP or COL would need to obtain an ACE Section 404 permit that would

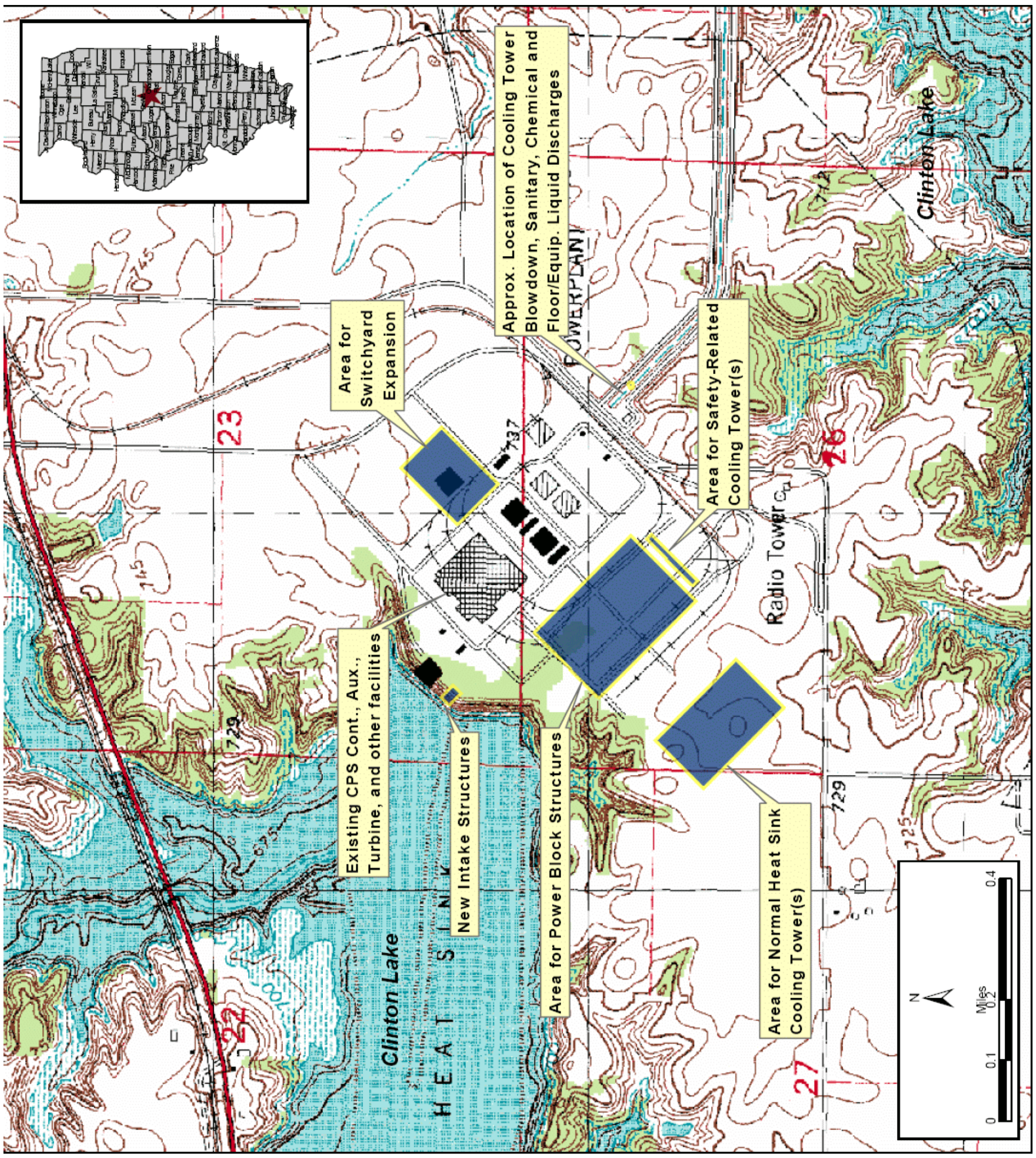

Figure 4-1. Areas Proposed for the Structures of a New Nuclear Unit (Exelon 2006a)

address these areas before undertaking any construction activities. The ACE's permitting process ensures that impacts of construction are limited by requiring that the appropriate construction best management and mitigation practices be followed.

Exelon currently anticipates that four new 345-kV transmission lines (two parallel, double-circuit lines running north to the Brokaw Substation near Bloomington and two running south to a point near the junction of the Latham-Rising Line, about 19 km [12 mi] from the CPS switchyard) would be required to accommodate the bounding case of an output of 2180 MW(e) from a new nuclear unit at the ESP site (see Section 3.3) (Exelon 2006a). Exelon anticipates that any transmission system upgrades would be located within or immediately adjacent to the existing CPS substation (for necessary switchyard expansion) and within or along the existing transmission line rights-of-way. Although transmission system improvements, such as the addition of new lines and support structures, would occur within the existing rights-of-way to the greatest extent possible, Exelon acknowledges that widening the existing rights-of-way from 40 m (130 ft) to 76 m (250 ft) likely would be required (Exelon 2006a).

However, the actual need for and nature of any transmission system improvements would be determined by the transmission and distribution system owner and operator (currently AmerenIP) under FERC Order No. 2003 (18 CFR Part 35), *Standardization of Generator Interconnection Agreements and Procedures* (FERC 2004). This order mandates performance of feasibility, system impact, and facilities studies when there is a proposed load increase on the existing transmission system of 20 MW(e) or more. If a new nuclear unit was constructed, any transmission system improvement studies and associated environmental impacts would be evaluated definitively by the transmission and distribution system owner and operator under FERC Order No. 2003 before or during the CP or COL stage.

The following is a description of three reasonable scenarios that span the range of construction impacts that could be incurred should new transmission lines be added to the existing system. In the first scenario, new transmission lines would be added to existing structures (e.g., via stacking) such that the effects of associated construction would occur entirely within the existing corridors currently used to transmit electricity from CPS (see Section 3.3). In this scenario, impacts would occur to wildlife habitat in established rights-of-way that are currently maintained via mechanical means and herbicides (see Section 5.4.1.4). The resulting impacts to wildlife habitat would be SMALL.

In the second scenario, new transmission lines and support structures would be added adjacent to the existing rights-of-way and the effects of associated construction would result in a doubling of the existing rights-of-way. This could result in the loss of 25 ha (61 ac) of adjacent forest (see Section 4.1.2). This loss of forested wildlife habitat over the approximately 69-km (43-mi) transmission line corridors would also be considered SMALL. Because the majority of land use along the existing transmission corridor is agricultural, the existing corridor does not cross any sensitive habitat areas, and because best management practices would limit the clearing of forest to the extent practicable, the resulting impacts to wildlife habitat under this scenario would be considered SMALL.

In the third scenario, one or more new rights-of-way would be needed to accommodate the addition of new transmission lines. The locations of any such new rights-of-way cannot be predicted with any reliability at this time. It is likely that the majority of the length of any new rights-of-way would traverse primarily agricultural land because it is the most prevalent land use in the region surrounding the ESP site. However, it is also possible that habitats set aside for the purpose of wildlife conservation (e.g., State wildlife areas) or relatively uncommon habitats (e.g., forest, prairie, wetlands, etc.) important to wildlife and/or to Federally protected species (e.g., the Indiana bat [*Myotis sodalis*] [see Section 4.4.3]) could be traversed by new rights-of-way. In this case, construction impacts to wildlife habitat from creation of one or more new corridors could range from SMALL to LARGE.

Construction for any transmission system improvements would impact agriculture and open fields within or along the existing rights-of-way, but these would be replanted and allowed to revegetate, respectively, to pre-construction conditions. Consequently, there would be only a temporary loss of agricultural or open field habitat resulting from construction of transmission system improvements. Where right-of-way expansion would be required in forested lands, cutting would be conducted to minimize disturbance. The actual amount of disturbance associated with any transmission system improvements would be contingent, among other factors, on the construction techniques used; these would be determined following submittal of an application for a CP or COL.

Right-of-way clearing and waste disposal methods would be dictated in large part by landowner requirements. However, without direction from the property owner, clearing would be done in accordance with industry guidelines and best practices (Exelon 2006a). These include use of approved erosion and sediment control measures to prevent transport of silts and sediments from the area of disturbance, topsoil stripping to avoid mixing and compaction of soils, special construction techniques in wetlands and other sensitive areas, and post-construction restoration measures approved by local, State, and Federal agencies (Exelon 2006a).

There are three 100-year floodplains within the existing transmission line rights-of-way, and there are minor wetland areas in the vicinity. Adverse impacts to watercourses, wetlands, and floodplains would be avoided to the greatest extent possible during construction for any transmission system upgrades. For example, transmission towers would be sited in upland areas (Exelon 2006a), which would help minimize potential impacts on watercourses, wetlands, and floodplains. Further, if impacted, these would be restored so that there would be no net loss of these resources.

Before issuing a construction permit, the transmission system owner and operator would also need to ensure that an applicant referencing the Exelon ESP in an application for a CP or COL would obtain an ACE Section 404 permit that would address such areas as wetland filling, vegetation clearing, hydrological alterations, etc. The ACE's permitting process ensures that impacts of construction are limited by requiring that the appropriate construction best management and mitigation practices be followed. Future environmental documentation would provide sufficient information about the wetlands to support a detailed description of potential construction impacts, and best management practices and mitigation that would limit impacts.

4.4.1.2 Wildlife

During construction of a new nuclear unit at the Exelon ESP site, wildlife could be destroyed or displaced, primarily as a result of operating heavy equipment (e.g., for land clearing). Less mobile animals (e.g., reptiles, amphibians, small mammals) would likely incur greater mortality than more mobile animals (e.g., birds). Relatively large tracts of open fields and some small forest parcels would be available to displaced animals just west and south of the power-block and cooling tower footprints. Species that can adapt to disturbed or developed areas, e.g., raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), and northern cardinal (*Cardinalis cardinalis*), might recolonize portions of the disturbed area where suitable habitat remained or had been replanted. To minimize construction-related impacts to wildlife (e.g., destruction of nests and eggs of migratory birds), Exelon would adhere to any permit conditions designed to restrict the timing of construction activities based on important biological periods (e.g., nesting of migratory birds).

Construction impacts to wildlife in the Clinton Lake State Recreation Area would likely be negligible because of the very small section of shoreline that would be disturbed for the new intake, relative to the total 132 km (82 mi) of shoreline. Impacts associated with the new intake would be expected to consist of very localized destruction and displacement of wildlife during construction, with some recolonization following construction. Due to its distance from the Exelon ESP site (10 km [6 mi]), no impacts to wildlife within the Weldon Springs State Recreation Area would be anticipated as a result of construction of a new nuclear unit (Exelon 2006a).

Construction of a new nuclear unit would proceed according to Federal and State regulations, permit conditions, existing procedures, good construction practices, and established best management practices (e.g., directed drainage ditches, silt fencing). Fugitive dust would be minimized by watering the access roads and construction site as necessary. Thus, impacts from dust would be considered negligible and further mitigation would not be warranted. Emissions from heavy construction equipment would be minimal due to scheduled equipment maintenance procedures.

Construction activities would generate noise due to the movement of workers, materials, and equipment, and the operation of construction equipment (e.g., earth-moving equipment, portable generators, pile drivers, pneumatic equipment, and hand tools). Noise generated by human activity can affect wildlife by inducing physiological changes, nest or habitat abandonment, and behavioral modifications, or it may disrupt communications required for breeding or defense. However, wildlife often adapt to noise generated by human activity (Larkin 1996). It has been estimated that construction noise levels 15 m (50 ft) from the source would range from 76 to 100 decibels on the A scale (Exelon 2006a). These noise levels would not be expected to extend far beyond the boundaries of the ESP site because at a distance of 122 m (400 ft) from the source most construction noise ranges from approximately 60 to 100 decibels on the A scale (Golden et al. 1980). Much of the noise in this range is below the threshold of 80 to 85 decibels on the A scale at which birds and small mammals are startled or frightened (Golden et al. 1980). Additionally, construction would occur near the CPS, where wildlife has presumably become accustomed to typical operating facility noise levels. Thus, noise from construction activities would not be likely to disturb wildlife beyond 122 m (400 ft) from the source and impacts within this distance are considered negligible because there are no important terrestrial species (as defined in NRC 2000) on the ESP site.

Avian collisions with fabricated structures are a result of numerous factors related to species' characteristics, such as flight behavior, age, habitat use, seasonal habits, and diurnal habitats, as well as to environmental characteristics, such as weather, topography, land use, and orientation of the structures. Most authors on the subject of avian collisions with utility structures agree that collisions are not a biologically significant source of mortality for thriving populations of birds with good reproductive potential (EPRI 1993). The NRC (1996) reviewed monitoring data concerning avian collisions at nuclear power plants with large cooling towers and determined that the overall avian mortality is low. No avian collisions with existing structures at the CPS site have been reported (Exelon 2006a); however, there is currently no monitoring plan in place at the CPS that facilitates detection and reporting of dead birds. The number of construction-related bird collisions with structures is expected to be negligible.

Daily traffic on Illinois SR 54 and 10 near the Exelon ESP site currently consists of 2750 cars and 2000 trucks. During construction, daily traffic on these highways would be expected to increase by an additional 1650 cars and trucks on each highway (an increase of about 60 and 83 percent for Illinois SR 54 and 10, respectively). During that time, wildlife mortalities due to collisions would thus be expected to increase, but only marginally (Exelon 2006a). Consequently, impacts to wildlife from increased traffic are expected to be negligible.

No impacts to State-listed threatened or endangered terrestrial plant species are anticipated because none is known to occur on or within 16 km (10 mi) of the Exelon ESP site (IDNR 2004).

There are no State-listed threatened or endangered terrestrial animal species known to occur on or within 16 km (10 mi) of the Exelon ESP site (IDNR 2004). However, according to Exelon, the local Audubon Society and other birding sources in Illinois have reported sightings of several State-listed threatened or endangered bird species in the vicinity (see Section 2.7.1.1 for additional details) (Exelon 2006a). Individuals of these species that frequent the vicinity of the ESP site would be expected to be minimally exposed, if at all, to disturbance (e.g., noise, human presence, etc.) associated with construction of a new nuclear unit at the site and any transmission system upgrades. Consequently, it is expected that construction impacts to State-listed animal species would be negligible.

4.4.1.3 Terrestrial Ecosystem Impact Summary

On the ESP site the impacts of construction (including land-clearing, construction noise, fugitive dust, equipment emissions, avian collisions with structures, and traffic mortality) on wildlife, including State-listed species, and on wildlife habitat, including loss of forest, would be minimal. No construction impacts to wetlands onsite are anticipated. Impacts on wildlife habitat and wildlife populations associated with the transmission system could be SMALL if additional transmission capacity were to be accommodated within the existing right-of-way, and SMALL if the existing right-of-way required expansion. However, they could range from SMALL to LARGE if new rights-of-way were to be required. Therefore, the staff concludes that this issue is unresolved, and analysis would need to be conducted by the transmission and distribution system owner and operator prior to or during the CP or COL phase.

4.4.2 Aquatic Impacts

Impacts to the aquatic ecosystem from construction of a new nuclear unit at the Exelon ESP site would mainly be associated with construction of a new cooling water intake structure. It is expected there would be loss of benthic macroinvertebrates and some open water and shoreline habitat at Clinton Lake, as well as temporary displacement of other aquatic species.

The proposed location for a new cooling water intake structure is approximately 19.8 m (65 ft) west of the existing CPS intake structure (see Figure 4-1) (Exelon 2006a). Based on the anticipated intake velocity and flow rate for a new nuclear unit at the ESP site, Exelon expects the intake would be approximately 34 by 46 m (110 by 150 ft) in dimensions (Exelon 2006a). During construction, fish (including those with recreational value, as described in Section 2.7.2.1) might be displaced from part of the nearshore as a result of methods used to displace water from the construction zone. Noise associated with the construction activity and increased turbidity and boating activity associated with dredging activities might also cause fish to leave the area temporarily. Use of best management practices to minimize sedimentation and timing of construction activities to minimize impacts on fish during critical spawning or rearing periods are both ways to mitigate potential impacts. Once construction was complete, it is expected that fish would return to the area. Benthic macroinvertebrates and nearshore habitat would be lost as a result of dredging, dewatering, and other construction activities.

However, the amount of open water, shoreline, benthic habitat, and benthic fauna that would be lost would be a small fraction of the total present at Clinton Lake.

No impacts to the aquatic ecosystem as a result of construction of a new nuclear unit are anticipated at any of the important aquatic habitats described in Section 2.7.2 (Exelon 2006a). These include the environmentally sensitive areas along Tenmile Creek and Salt Creek, the Weldon Springs State Recreation Area, and the several small wetlands associated with tributaries to Salt Creek, the North Fork of Salt Creek, and the sediment basins within the CPS site.

Two State-listed threatened mussel species, the slippershell mussel (*Alasmidenta viridis*) and the spike (*Elliptio dilatata*) are included in the INHS list, "Mussels of DeWitt County" (INHS 2003). Exelon queried a 2002 IRNR GIS database and found no documented occurrences of the slippershell mussel in Clinton Lake or any other watercourse in the vicinity of the ESP site (Exelon 2006a). The spike is known to occur approximately 16 km (10 mi) from the ESP site. However, adverse impacts to this species are not anticipated because this nonmotile mussel is so distant from the cooling-water intake construction site (Exelon 2006a). No impacts to any other State-listed threatened or endangered aquatic animal or plant species is anticipated because none is known to occur in the vicinity of the ESP site (Exelon 2006a; IDNR 1999). Exelon has committed to contact the IDNR before commencement of construction activities to ensure that these assumptions remain valid.

In conclusion, impacts to aquatic species and habitat from construction of a new nuclear unit at the Exelon ESP site are expected to be SMALL, and mitigation would not be warranted.

4.4.3 Threatened or Endangered Species

This section describes the potential impacts to Federally listed or proposed threatened or endangered aquatic and terrestrial species and associated designated and proposed critical habitat resulting from construction of a new nuclear unit on the Exelon ESP site, and anticipated transmission system upgrades. The biology of these species is presented in Sections 2.7.1 and 2.7.2.

The staff has prepared a biological assessment documenting the expected impacts resulting from construction of a new nuclear unit to the Federally listed threatened and endangered terrestrial species described in U.S. Fish and Wildlife Service (FWS) correspondence (FWS 2004). The staff's impact determinations from the biological assessment are reiterated in this section.

Construction Impacts at the Proposed Site

There are two Federally listed species, the threatened bald eagle (*Haliaeetus leucocephalus*) and the endangered Indiana bat (*Myotis sodalis*), that may occur in the vicinity of the ESP site and transmission line corridors (FWS 2004).

Bald Eagle - Threatened

Bald eagles are not known to nest, but are known to winter along large rivers, lakes, and reservoirs in DeWitt County (FWS 2004) and have been observed in the vicinity of the ESP site (Exelon 2006a). However, there are no known night roost sites in DeWitt County (FWS 2004). Further, no concentrations of foraging eagles have been reported on or in the vicinity of the Exelon ESP site (Exelon 2006a; FWS 2004; IDNR 2004). Individual bald eagles that frequent the vicinity of the ESP site could be exposed, albeit minimally if at all, to disturbance (e.g., noise, human presence, etc.) associated with construction of a new nuclear unit or any transmission system upgrades. If transmission system improvement studies (see Section 4.4.1.1) indicated that transmission system upgrades required clearing forest habitats, the transmission and distribution system owner and operator would determine the presence of any eagles in the vicinity and conduct an evaluation of potential impacts. No critical habitat is designated for the bald eagle (FWS 2004). Consequently, because there are no known nests, night roosts, or foraging concentrations in the vicinity of the ESP site or along the existing transmission corridors, construction impacts to bald eagles are expected to be negligible.

Indiana Bat - Endangered

Because the Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004), it could occur on and in the vicinity of the ESP site although there are no records of its occurrence within 16 km (10 mi) (IDNR 2004). If present, Indiana bats would most likely occur in association with small streams with well-developed riparian woods, as well as with mature floodplain and upland forests. The Indiana bat roosts and rears its young beneath the loose bark of large dead or dying trees and tends to return to the same roosting area year after year (FWS 2004).

To be impacted by the project, suitable Indiana bat summer habitat must occur within 0.8 km (0.5 mi) of the project site. If suitable summer habitat occurred in any area on the ESP site or along any transmission line rights-of-way where construction would take place and the species was present, impacts could occur if forests are cleared. Large-scale habitat alterations within known or potential Indiana bat summer habitat should not be undertaken without a bat survey and/or consultation with the FWS Rock Island, Illinois, Field Office. Minor alterations of summer habitat (e.g., clearing small forest stands) should be limited to non-maternity periods between September 16 and April 14. All potentially suitable habitat should be surveyed to determine if it is suitable and, if so, if it is occupied (FWS 2004).

The staff expects that an applicant referencing the Exelon ESP in an application for a CP or COL would determine, before commencement of construction, if the approximately 1.2-ha (3-ac) forest stand within the power block footprint and the approximately 0.2-ha (0.5-ac) forest stand within the new intake footprint, for a total of 1.4 ha (3.5 ac), were potentially suitable for Indiana bats, using the criteria found in Section 2.7.1.2 or other contemporaneous criteria established by the FWS. If these forest stands were not potentially suitable, they could be cleared without any timing restrictions for Indiana bats, but timing restrictions imposed for other species, e.g., migratory birds, are still applicable. However, if they were found to be potentially suitable, they would be surveyed to determine their suitability and there would be a determination of whether or not they were occupied by the Indiana bat. If the forest habitat was suitable and unoccupied, clearing could be undertaken during the nonmaternity period between September 16 and April 14. However, if the habitat was suitable and occupied, forest clearing activities should not take place without first consulting with the FWS Rock Island, Illinois, Field Office. The NRC staff would undertake a Section 7 FWS consultation, if appropriate.

If transmission system improvement studies (see Section 4.4.1.1) indicated that transmission system upgrades required clearing forest habitats, the transmission and distribution system owner and operator would determine its suitability as Indiana bat summer habitat and occupancy, as explained above, before forest clearing activities were undertaken. Furthermore, compliance would be necessary with any timing or other contemporaneous restrictions imposed by FWS for protection of the Indiana bat.

Indiana bats winter in caves and abandoned mines (FWS 2004), but such habitat features are not known to occur on the ESP site or along its transmission line rights-of-way. The only critical habitat designated for the Indiana bat is the Blackball Mine in LaSalle County, Illinois (FWS 1976). Consequently, there would be no construction impacts to Indiana bat critical habitat because none occurs in the vicinity of the ESP site.

Because there are no known occurrences of the Indiana bat within 16 km (10 mi) of the ESP site, impacts from construction to the species are expected to be negligible.

Federally Listed or Proposed Aquatic Animals

No impacts to Federally listed or proposed threatened or endangered aquatic animal species or associated proposed or designated critical habitat are anticipated (Exelon 2006a; FWS 2003, 2004; IDNR 1999), because none is known to occur on or within 16 km (10 mi) of the ESP site or in the vicinity of the transmission line corridor (FWS 2004).

Construction Impacts at the Proposed Site

Federally Listed or Proposed Terrestrial and Aquatic Plants

No impacts to Federally listed or proposed threatened or endangered terrestrial (FWS 2004) or aquatic (Exelon 2006a; FWS 2003, 2004; IDNR 1999) plant species are anticipated because none are known to occur on or within 16 km (10 mi) of the ESP site (IDNR 2004) or in the vicinity of the transmission line corridor (FWS 2004).

Conclusions

In summary, there would be no construction impacts to Federally listed or proposed terrestrial or aquatic plant species. There would be no construction impacts to Federally listed or proposed aquatic animal species. Construction impacts to Federally listed terrestrial animal species, the bald eagle and Indiana bat, are expected to be negligible. There would be no construction impacts to designated or proposed critical habitat for Federally listed or proposed terrestrial or aquatic animal species. Exelon has committed to contact the FWS before beginning construction activities to ascertain whether these assumptions remain valid or whether further evaluation is needed.

Based on its review of impacts resulting from construction of a new nuclear unit at the Exelon ESP site and associated transmission line rights-of-way, the staff determined that the impacts of construction on Federally listed or proposed threatened or endangered aquatic or terrestrial species would be SMALL, and mitigation would not be warranted. The conclusion of SMALL impacts by the NRC staff is predicated on certain assumptions made by the staff. These include the current occurrence of Federally listed threatened and endangered species and critical status of such species, and the current designation of critical habitat.

4.5 Socioeconomic Impacts

This section discusses the socioeconomic impacts of construction activities. It includes impacts that could result from the construction-related activities at the Exelon ESP site and from the activities and demands of the workforce on the surrounding region. Evaluated socioeconomic impacts include potential effects on individual communities, the surrounding region, and minority and low-income populations.

4.5.1 Physical Impacts

Construction activities at the ESP site might cause temporary and localized physical impacts, including, but not limited to, noise, odor, vehicle exhaust, and dust. This section qualitatively addresses these potential impacts as they might affect people, buildings, roads, and recreational facilities (such as Clinton Lake).

4.5.1.1 Workers and the Local Public

Within the ESP site boundary, 100 percent (187 ha [461 ac]) has been graded or otherwise developed for the operation of the existing nuclear power plant. Except for the CPS, there are no industrial, commercial, or institutional structures on the site property. Industrial land use is the only type of land use within the site (Exelon 2006a).

The area around the CPS site is 82 percent agricultural land. Industrial land use is less than 1 percent and is limited to areas near Clinton and Weldon. Less than 1 percent of land within the site vicinity is residential and consists primarily of areas in Clinton and Weldon (Exelon 2006a).

Recreational areas are the only special land uses within the vicinity (16.6 percent of total land use), consisting of the Clinton Lake State Recreation Area and Weldon Springs State Recreation Area (Exelon 2006a).

People who work or live around the proposed ESP site could be subjected to noise, fugitive dust, and gaseous emissions resulting from construction activities. Construction workers and personnel working onsite could be the most impacted. Next impacted would be individuals working or living immediately adjacent to the site and least impacted would be transient populations, such as temporary employees, recreational visitors to Clinton Lake, and tourists passing through the area.

Onsite mitigation efforts and the relative isolation of the ESP site from neighboring residential houses would mitigate the potential adverse impacts normally expected from increased noise levels. Activities with significant noise impacts, such as blasting, would be limited to normal weekday business hours. In addition, noise levels would be controlled by using the following State and Federal criteria (Exelon 2006a):

- The Occupational Safety and Health Administration (OSHA) noise-exposure limit to workers and workers' annoyance that are determined through consideration of acceptable noise levels for offices, control rooms, etc. (29 CFR 1910.95)

- Federal (40 CFR Part 204) noise-pollution control regulations

- State regulation, the Illinois Administrative Code, Title 35, *Environmental Protection*, Subtitle H: Noise, or local noise-pollution control rules (35 IAC 2003, 2004, and 2006).

Dust emissions would occur with onsite construction activity and exhaust emissions with the operation of construction equipment and vehicles. Fugitive dust and fine particulate matter emissions, including those less than 10 microns (PM_{10}) in size, will be generated during earth-moving, material-handling, and open burning of construction waste. PM_{10} emissions can impact human health, e.g., respiratory diseases. Other pollutants of potential concern are emissions of oxides of nitrogen, carbon monoxide, reactive organic gases, and sulfur dioxide.

Sensitive receptors are not proximate to the construction site. The nearest residence to the planned construction site is 1.2 km (0.73 mi) away and the nearest campground, church, and school are 1.6 km (1 mi), 6.1 km (3.8 mi), and 7.7 km (4.8 mi) distant from the site, respectively (Exelon 2006a). Exelon would be subject to applicable Federal, State, and local regulations governing emissions from construction activities and vehicular traffic. In Illinois, dust generated as part of construction activities is exempt from State permit requirements (Exelon 2006a), even though fugitive dust and fine particulate matter emissions may be subject to EPA air-pollution standards.

Exelon has stated it would adhere to applicable air-pollution control regulations as they relate to open burning or the operation of fuel-burning equipment. Even though dust generated from construction activities is exempt from State permit requirements, Exelon has committed to mitigate dust emissions to the extent possible (Exelon 2006a).

In summary, offsite noise impacts would be expected to be minor because of the noise-control devices on the vehicles, the adherence to applicable State and Federal criteria, the distance of nearby residences to the site, and the fact that construction activities entailing significant noise impacts would be limited to normal weekday business hours. Exelon has stated it would adhere to applicable air-pollution control regulations as they relate to open burning or the operation of fuel-burning equipment and mitigate dust emissions from construction to the extent possible. Therefore, based on the information provided by Exelon and the staff's independent verification during a site visit the week of March 1, 2004, the staff concludes that any physical impacts of construction to the workers and the local public would be SMALL, and further mitigation beyond the mitigation actions stated above would not be warranted.

4.5.1.2 Buildings

It is not expected that construction activities would impact any offsite buildings. Most buildings not located on the site are well away from the site boundaries. The buildings most vulnerable to shock and vibration from pile driving are those located on the ESP site.

Based on the staff's independent review and verification during a site visit the week of March 1, 2004, the staff concludes that any physical impacts of construction on offsite buildings would be SMALL, and mitigation would not be warranted.

4.5.1.3 Roads

Exelon stated that none of the roads and highways in the vicinity would be physically impacted by constructing a new nuclear unit at the ESP site. The roads and highways would have to accommodate an increase of approximately 3300 vehicle trips. Exelon estimated that if each construction worker commuted individually, 50 additional miscellaneous trips would occur throughout the day and 100 truck deliveries during the peak hours of the workday. Exelon concludes that, because these roads and highways are two-lane, rural, and not heavily traveled, they could withstand the increase in vehicular traffic (Exelon 2006a).

The major State highways in the area of the proposed Exelon ESP site (Routes 10 and 54), have maximum weight limitations set by Illinois at 36,281 kg (80,000 lbs). While there are weight limitations on some of the bridges on these routes, there are ways, using State, county and Harp Township roads and overweight permits, of getting loads in excess of 36,281 kg (80,000 lbs) into the Exelon ESP site. For example, loads in excess of 54,422 kg (120,000 lbs) have been brought into the CPS in the past.[a][b] However, if loads of this weight were consistently hauled over roads with an 36,281 kg (80,000 lbs) weight limitation, one could expect some physical impacts on the roads' conditions.

The staff observed during its site visit that the roads in the vicinity of the ESP site are lightly traveled and well maintained. However, if all construction materials were hauled over these roads by truck, the rural roads might be physically impacted by the heavy loads. Exelon did not give any justification for its statement that none of the roads or highways in the vicinity would be adversely physically impacted. Therefore, based on the information provided by Exelon, the staff's independent verification during a site visit the week of March 1, 2004, and follow up discussions with knowledgeable DeWitt County and Harp Township officials, the staff concludes that any impacts of construction on roads would be SMALL to MODERATE. Mitigation of moderate impacts could be achieved by upgrading the existing rail line into the Exelon ESP site and hauling the heavier construction material by rail and/or keeping the weight of trucks hauling construction materials under the 36,281 kg (80,000 lbs) weight limitations set by Illinois.

4.5.1.4 Aesthetics

The proposed construction site is far removed from most of the permanent population that would view the construction activities. The closest residence is approximately 1.2 km (0.73 mi) to the southwest, and the closest town is DeWitt, which is approximately 5 km (3 mi) to the east.

(a) Telephone conversation with Terry Ferguson (DeWitt County Board, Land Use chairman and Harp Township Highway Commissioner), January 9, 2006.
(b) Telephone conversation with Craig Fink (DeWitt County Highway Department), January 10, 2006.

Construction Impacts at the Proposed Site

Recreational users of Clinton Lake would be able to view the construction areas from certain parts of the lake surface. However, for most of Clinton Lake, the construction area would not visually impact most recreational users and areas of the lake. Mitigation measures planned by Exelon to lessen the visual impact of construction activities from the lake would include restricting construction laydown to as small an area as possible and removing construction debris from the site in a timely and suitable manner (Exelon 2006a).

Construction of new transmission line rights-of-way would be required to support a new nuclear unit at the ESP site. These lines would be within the existing maintained utility rights-of-way to the greatest extent possible and hence would be in rights-of-ways already disturbed. Construction of the proposed transmission line rights-of-way might temporarily impact watercourses existing along the proposed rights-of-ways, including Clinton Lake. It is expected that the visual impacts caused by construction would be temporary (Exelon 2006a).

In summary, the staff considered the overall visual impacts at distances away from the proposed ESP site, which revealed that the visual impacts of construction on offsite viewers would be limited. The impacts of constructing or installing new transmission lines within existing rights-of-ways would be temporary. Exelon stated that it would abide by applicable Federal and State laws to control runoff and sedimentation in the lake, which could affect the aesthetic enjoyment of the lake, and, if necessary, they would do more to control runoff to Clinton Lake. Therefore, based on the information provided by Exelon and the staff's independent review during a site audit the week of March 1, 2004, the staff concludes that the impacts of construction on aesthetics would be SMALL, and further mitigation beyond the mitigation actions stated above would not be warranted.

4.5.2 Demography

Population within the 80-km (50-mi) radius of the region is 764,366 and projected to grow to 942,556 by 2060, for a total increase over the 60-year period of 23.3 percent (see Table 2-6). Exelon anticipates employing 3150 construction workers to build a new nuclear unit at the ESP site (Exelon 2006a). Most of these workers are anticipated to come from within the region (see further discussion under Section 4.5.3.1). Thus, increases in population directly attributable to the construction workforce would be minimal.

Some new jobs might result from the multiplier effect[(a)] attributable to the construction workforce. But these increases, when compared to the total population base in the region, would be minimal as well.

Should a larger-than-expected number of construction workers decide to locate to DeWitt County, there could be a noticeable increase in population, but it would not be excessive. If 20 percent of the construction workforce, or 650 workers, decided to relocate temporarily to DeWitt County, it would represent only a 3.9-percent increase in total population, based on 2000 Census data. Any multiplier effects resulting from construction worker expenditures would most likely mean that some residents would obtain new or higher-paying jobs as a result of the increased economic activity.

In summary, most construction workers would be expected to come from within the region. The number of construction workers who might relocate to the region is a small percentage of the larger population base. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of construction on increases in population within the region would be SMALL, and mitigation would not be warranted.

4.5.3 Impacts to the Community

This section evaluates the social, economic, infrastructure, and community impacts to the surrounding region as a result of constructing a new nuclear unit at the Exelon ESP site. The evaluation assesses impacts of construction and of those demands placed by the workforce on the surrounding region. It is expected that construction activities would last up to 5 years and employ up to 3150 construction workers (Exelon 2006a). This is in addition to the estimated 550 permanent operations personnel currently employed at the CPS site and the 1300 temporary workers during refueling outages lasting up to three weeks (Exelon 2006c).

4.5.3.1 Economy

The impacts of construction at the ESP site on the local and regional economy depend on the region's current and projected economy and population. Some insight can be obtained on the projected economy and population by consulting county comprehensive plans and data from the U.S. Census Bureau. The ESP, if approved, will be in effect for 20 years after approval. Within that period, construction of safety-related facilities could start at any time once a CP or COL authorizing construction has been issued. In addition, the issuance of an ESP allows,

(a) In the multiplier effect, each dollar spent on goods and services by a construction worker becomes income to the recipient who saves some but re-spends the rest. His re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier."

under certain regulatory conditions, the start of limited early construction activities. Therefore, the positive economic benefits of construction could begin some time before the start of the construction of the principal structures of the facility.

It is expected that construction activity would last between 3 and 5 years and employ 3150 construction workers at the peak (in addition to the estimated 550 permanent operating personnel currently employed at the CPS and 1300 temporary workers employed during refueling outages). The construction workforce peak usually occurs during the installation of piping and electrical wiring, which takes place when 50 to 70 percent of construction is completed. Exelon anticipates that the workforce would then continue to decline steadily until completion of the job (Exelon 2006a).

The employment of such a large workforce for such a period of time would have economic impacts on the surrounding region. DeWitt County would probably be the most impacted. From there, the impacts would become diffuse as a result of interacting with the economic base of the surrounding counties, particularly the larger economies of Macon, McLean, and Champaign Counties. The magnitude of the impacts hinges on (1) the percentage of the construction workforce who would come from within the 80-km (50-mi) radius of the region and thus commute to the construction site and (2) those who would relocate to the area to live in DeWitt, Piatt, or Logan Counties or the larger cities of the area such as Decatur, Bloomington–Normal, or Urbana-Champaign.

The construction workforce of 3150 workers would create additional jobs in the region through the multiplier effect of direct employment. The expenditures of the construction workforce in the region for food and services could, through the multiplier effect of those expenditures, also create a number of new jobs.

During its review, the staff questioned whether there would be a sufficient number of construction workers (3150) available, with the requisite skills, to build a new nuclear unit at the ESP site. The staff analysis and information obtained from the interviews conducted by the staff during a site visit the week of March 1, 2004, confirm that sufficient numbers of construction workers would be available to meet demand.

In the counties surrounding the ESP site (Champaign, DeWitt, Logan, McLean, Macon, and Piatt Counties), there are 16,214 workers in the construction industry (see Table 2-14). In the region (within 80 km [50 mi]) of the CPS, there were 38,485 people employed in the construction industry in the year 2000 (Exelon 2006a). In the construction of the CPS, more than 9000 workers were employed, with a significant number of that workforce coming from within the region (Exelon 2006a). In addition, it is not unusual for construction workers to commute fairly long distances to a project site. Based on the information provided by Exelon and the staff's independent review, the staff concludes that there would be little problem in recruiting the required labor skills to enable construction of a new nuclear unit at the ESP site.

In summary, the magnitude of the positive economic impacts of construction would be diffused in the larger economic bases of Macon, McLean, and Champaign Counties. DeWitt County is the site of the construction, and as a result, would be impacted more than Piatt and Logan Counties. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of construction on the economy of the region would be beneficial and SMALL everywhere in the region except DeWitt County, where the impacts could be beneficially MODERATE, and that mitigation would not be warranted.

4.5.3.2 Taxes

The type of reactor selected would impact the size of the workforce and, thus, the amount of taxes paid. Because reactor selection would occur only if Exelon decides to proceed with a CP or a COL, only a qualitative assessment of the impacts to the surrounding area and region of interest can be provided at this time.

There would be several types of taxes generated by the construction of the plant and the workforce employed there. These include income taxes on wages and salaries paid and corporate profits, sales and use taxes on construction-related purchases, on other purchases by the construction workers and the sale and use taxes from the resultant multiplier effects; and property taxes related to the building of a new nuclear unit at the ESP site. Each is briefly discussed in turn.

Income Taxes

Illinois has a personal income tax, a flat tax of 3 percent on taxable income. As the Illinois return is based on the Federal return's adjusted gross income, income that is taxable at the Federal level is also generally taxed by Illinois (IDOR 2003). Construction workers and employees of Exelon would pay income taxes to Illinois if their residences were in Illinois or if they were nonresidents working in Illinois (IDOR 2003). While the exact amount of tax payable to Illinois is not known, it could be fairly large over a 3- to 5-year construction period.

Corporations in Illinois pay a flat 4.8 percent income tax and a 2.5 percent replacement tax. Before 1979, business entities were required to pay personal property taxes. Legislation then abolished the personal property taxes. To replace the money lost by units of local government and school districts, the replacement tax was enacted. The replacement tax is income taxes received from corporations (including S corporations), partnerships and trusts, collected by the State of Illinois and paid to local governments (IDOR 2004a).

Corporations undertaking the construction of a new nuclear unit at the Exelon ESP site would pay corporate income and replacement taxes on the net income earned from the construction activity (IDOR 2004a). Again, while the exact amount of tax payable to Illinois is not known, it could be fairly large, in absolute terms, over the 3- to 5-year construction period.

The salaries of the construction workforce would have a multiplier effect, where money is spent and re-spent within the region. Because of the multiplier effect, local businesses in and around the City of Clinton probably would see an increase in business, especially in the retail and services sectors. This would have a positive impact on the business community within the vicinity, could provide opportunities for new businesses to get started, and could provide increased job opportunities for residents of the area. In addition, these businesses and employees would have profits or increases in profits upon which income taxes would be paid, as well.

Sales and Use Taxes

Illinois has two types of sales and use taxes. Sales taxes are imposed on a seller's receipts from sales of tangible personal property for use or consumption. In Illinois, the term "sales tax" actually refers to several tax acts. Sales taxes are a combination of "occupation" taxes that are imposed on seller's "receipts" and "use" taxes that are imposed on amounts paid on purchases. Sellers owe the occupation tax to the Illinois Department of Revenue; they reimburse themselves for this liability by collecting use tax from the buyers.

The "sales tax" is the combination of all state, local, mass transit, water commission, home-rule occupation and use, non-home-rule occupation and use, and county public safety taxes. The tax rate is 1 percent for qualifying food, drugs, and medical appliances and 6.25 percent for everything else (IDOR 2004b). Of that, 5 percent goes to the State of Illinois, 1 percent goes to the municipalities in which it was collected, and 0.25 percent goes to the county in which it was collected.

Illinois and the counties surrounding the Exelon ESP site would experience an increase in the amount of sales and use taxes collected from construction materials and supplies purchased for the project. Additional sales and use taxes would be generated by retail expenditures of construction workers (restaurants, hotels, merchant sales, and food). It is difficult to assess which counties and local jurisdictions would be most impacted by the expenditures and resultant sales and use taxes collected. It is probable that the City of Clinton could receive a large increase in taxes collected given its location near the ESP site. Other towns of significant size are more than 30 km (20 mi) from the site, making it more likely that workers would seek services and make purchases at locations closer to the ESP site.

Property Taxes

Property taxes would be paid on the ESP Facility as it is constructed, and would accrue to DeWitt County and other jurisdictions currently benefitting from the property taxes paid by CPS. In addition, DeWitt and surrounding counties would benefit from property taxes resulting from any new construction precipitated as a result of the construction of a new nuclear unit at the ESP site; e.g., new houses and businesses. However, these impacts are expected to be beneficially small, especially from new housing construction since most construction workers are expected to already reside in the region.

Summary of Tax Impacts

In summary, the amount of income taxes collected over a potential 3- to 5-year construction period could be large in absolute amount, but small when compared to the total amount of taxes that Illinois collects in any given year or in a 5-year period. In absolute terms, the amount of sales and use taxes collected over a potential 3- to 5-year construction period could be large, but small when compared to the total amount of taxes collected by Illinois and the governmental jurisdictions within the region. However, given its proximity to the ESP site and smaller economic base, the City of Clinton could be the exception and the sales and use taxes collected could have a moderate impact. The taxes collected would be of benefit to both State and local jurisdictions. The amount of property taxes collected from the ESP site's construction is expected to increase as the percentage of construction completeness rises. The property taxes would accrue to DeWitt County and other jurisdictions currently receiving property taxes from CPS. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential beneficial impacts of taxes collected during construction would be beneficially SMALL, except DeWitt County where they would be beneficially MODERATE and that mitigation would not be warranted.

4.5.3.3 Transportation

To the extent possible, the CPS roads would be used for construction traffic. The site has at least one access road that can be used to transport heavy construction equipment (Exelon 2006a). Traffic and traffic-control impacts during construction might include, but are not limited to, the following: working adjacent to or in active roadways (day/night), traffic-control zones, traffic-control device installation and removal, flagging, inspection and maintenance of traffic-control devices, equipment, and general roadway traffic-control zone safety (Exelon 2006a).

The expected 3150 construction workers, the existing CPS permanent workforce of 550 employees and the 1300 temporary workers during refueling outages lasting up to three weeks, (Exelon 2006a, 2006c) would put increased traffic on the road system in the vicinity of the proposed Exelon ESP site. Increased use of the roads in the vicinity of the site would be particularly noticeable during shift changes.

To determine the impact of additional workers on traffic, Exelon obtained average daily traffic counts from the Illinois Department of Transportation (IDOT) website for Illinois SRs 54 and 10. Near the Exelon ESP site and using updated data, 2500 cars and trucks and 1850 cars and trucks travel daily on Illinois SRs 54 and 10, respectively (IDOT 2004). According to IDOT's *Bureau of Design and Environmental Manual*, the typical average daily traffic count for a rural two-lane highway is 5000 cars and trucks (Exelon 2006a).

Exelon calculated that during construction of the Exelon ESP facility, there could be an additional 1650 cars and trucks added to each highway. To arrive at these estimates, Exelon assumed a total of 3200 vehicle trips, plus 100 truck deliveries. The increased traffic was divided equally between Illinois SRs 54 and 10. Based on the addition of the average daily traffic counts and the assumed expected number of additional trips due to construction, Exelon concluded that the additional construction workers would not put an excessive amount of burden on the roadways near the ESP site. In its estimates, Exelon does not appear to have accounted for the existing operations workforce for the CPS.

As shown in Table 2-8, the population in DeWitt County, the county most impacted by the presence of the CPS and a new nuclear unit at the ESP site is projected to decrease from approximately 16,798 to 16,018, a decline of approximately 0.5 percent, between 2000 and 2010. It is expected to decrease by another 0.2 percent between 2010 and 2020. However, Clinton is billing itself as a bedroom community to the larger Cities of Champaign-Urbana, Decatur, Bloomington–Normal, and, to a lesser extent, Springfield.[a] It could be expected that if such billing is successful, increased growth in and around Clinton could occur. Another attraction, which could encourage such growth, is the relatively low tax base of DeWitt County when compared to other surrounding counties (see Section 2.8). So, while the Illinois Department of Commerce and Economic Opportunity forecasts a decline in population for DeWitt County as a whole, Clinton's growth aspirations, if successful, could increase the county's population, thus placing additional traffic on the area's roads and highways.

During the site visit the week of March 1, 2004, the staff observed that most of the roadways within DeWitt, Logan, and Piatt Counties are rural and lightly traveled. The current road system in the vicinity of the site is well-maintained, rural, and lightly traveled most times of the day. As

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(a) Group interview conducted March 2, 2004, in Clinton, Illinois, with Duane Harris (DeWitt County Board Chairman), Terry Ferguson (DeWitt County Board and Land Use Chairman), Sherrie Brown (Administrator, DeWitt County Zoning), Sandy Moody (DeWitt County Supervisor of Assessments), Dee Dee Rentmeister (Administrative Assistant, DeWitt County Board of Supervisors), and Christy Long (DeWitt County Treasurer) and personal interview conducted March 3, 2004, in the City of Clinton, Illinois, with Stephen Vandiver (Economic Development Director, City of Clinton).

discussed in Section 2.8, business route U.S. 51 through Clinton has had a center turn-lane constructed, which has alleviated congestion through Clinton at shift changes. Population growth could put pressure on the local transportation system but, given the state of the current transportation system around the ESP site, in DeWitt County and those counties abutting DeWitt, the local transportation system would probably not be overwhelmed with added construction traffic.

Should there be congestion, there are Federal regulations for traffic control signs, signals, and barricades (29 CFR Part 1926). Illinois State and U.S. Department of Transportation plans may have more stringent requirements. Exelon states that local, State, and Federal requirements would be adhered to regarding traffic control onsite and offsite during construction activities (Exelon 2006a). In addition, a way to alleviate truck traffic congestion is to upgrade the rail link to the ESP site.

In summary, the roads are currently lightly traveled and, except at shift changes, would not be overly congested by increased construction traffic. Exelon has stated it would adhere to applicable local, State, and Federal requirements regarding traffic control during construction of a new nuclear unit at the ESP site. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of construction on the transportation system would be SMALL and that mitigation, beyond that previously stated, would not be warranted.

4.5.3.4 Recreation

From most of Clinton Lake, the construction area would not be seen. Mitigation measures planned by Exelon would lessen the impact from the few places on the lake where the construction would be visible. Therefore, it is expected that the visual impacts of construction would have minimal impact on the recreational experiences of lake users.

There would be the potential for short-term water quality impacts on the lake from construction, which, if left unchecked, could impact open water, shoreline habitats (including benthic ecosystems), and water quality. Some fish species might be temporally displaced as a result of minor water quality impact disturbances surrounding the construction of the water-intake structure. This could, in turn, impact recreational opportunities on the lake, including fishing. Exelon has stated it would abide by applicable Federal and State regulations governing runoff and, where necessary, would implement additional special control measures to minimize impacts to the lake and lake users (Exelon 2006a).

In summary, the distance of recreational access points to the plant site effectively limits the impacts of construction to recreational users of the lake, and Exelon has committed to mitigation activities during construction, which should lessen impacts on the lake's water quality. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of construction of a new nuclear unit on aesthetic and recreational opportunities at Clinton Lake would be SMALL and that mitigation would not be warranted beyond Exelon's commitments.

4.5.3.5 Housing

Rental property is scarce in the rural counties in proximity to the Exelon ESP site, but is found in more plentiful supply in the larger cities such as Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield. Generally, the counties with larger populations (Champaign, McLean, Macon, and Springfield-Sangamon) have more available vacant housing. In 2000, there were 211,445 total housing units in counties close to the ESP site, i.e., Champaign, DeWitt, Logan, McLean, Macon, and Piatt Counties. Of the total housing units, 69,686 were renter-occupied, or 33 percent of the total. Vacant units numbered 13,183, or 6.2 percent of the total. The percentage vacancy rate varied, ranging from a low of 4.8 percent (Piatt County) to a high of 7.3 percent (Macon County). Macon County showed a decline in rental and vacant units between 1990 and 2000 (see Table 2-17).

Exelon estimates it would need a construction workforce of 3150 over a 3- to 5-year period to construct a new nuclear unit (Exelon 2006a). Impacts on housing from the construction workforce depend on how many workers come from within the region of interest (80 km [50 mi]) and already have housing, and those who might need to relocate to the area and thus require housing. Exelon maintains in its ER that the majority of the construction workforce would come from within the region (Exelon 2006a).

If the entire workforce was derived from within the 80-km (50-mi) radius of the region, there would be little or no impact on housing, except potentially on the smaller counties of DeWitt, Piatt, and Logan and the Cities of Monticello, Farmer City, Lincoln, and Clinton and only if workers sought more housing there than was available (see Tables 2-17 and 2-18).

Some construction workers might originate from outside the 80-km (50-mi) radius of the region. It is not unusual for construction workers to drive 80 km (50 mi) or more from their place of residence to a job site, and some might commute to the job site, stay the work week, and then return to their place of residence on the weekends. These workers would likely share motel accommodations, rooms over existing businesses and in homes in the area, and trailers and campers at existing mobile home parks. Increased demand for RV/trailer spaces could result in an increase in the number of spaces being made available through new construction. The issue of having adequate water and sewer services available is discussed in Section 4.5.3.6 of this EIS.

Assuming that trends remain much the same in the future as they were in 2000, there would be sufficient vacant housing to meet the demands put on the housing system by 3150 construction workers. This also assumes that some of the vacant units could and would be converted to rental housing. Most of the vacant units and rental-occupied housing would be found in the larger cities within 48 to 80 km (30 to 50 mi) of the Exelon ESP site.

However, if these assumptions prove incorrect, there could be a problem with housing availability, particularly in the smaller counties of DeWitt, Logan, and Piatt, where there is shortage of rental housing (see Tables 2-17 and 2-18). If too many “imported” workers tried to live in these counties, one would expect an upward effect on rents paid for housing. Some low-income populations could be priced out of their rental housing if there was upward pressure on rents. Such pressures are less likely to occur in the larger metropolitan area where there is a greater supply of rental housing.

In summary, most of the construction workforce would be expected to come from within the region. Generally, housing is available in the larger cities to accommodate any construction workers who might move into the region. However, if the assumption that most of the construction workforce would come from within the region is invalid, then there could be a shortage of housing in DeWitt, Logan, and Piatt Counties if too many “imported” workers tried to live in these counties. In addition, there could be upward pressure on rents. The 1300 temporary workers employed during refueling outages could further exacerbate any problems. Therefore, based on the information provided by Exelon and the staff’s independent review, the staff concludes that the potential impacts of the new nuclear unit construction on housing would be SMALL, if all the workers generally come from within the region and chose not to locate closer to work in DeWitt, Piatt, or Logan counties. But it could be MODERATE in DeWitt, Piatt, and Logan counties, if the assumption that all the workers would come from within the region proves invalid, or if a number of construction workers decide to relocate to these counties to be closer to work. Mitigation would not be warranted where the impacts are small. Mitigation of the moderate impacts would most likely be market-driven with temporary accommodations being provided and/or constructed.

4.5.3.6 Public Services

Water Supply and Waste Water Treatment Facilities

In the vicinity of the Exelon ESP site, drinking water is primarily obtained from municipal groundwater sources via wells. Only a small number of residents have private well systems. The Clinton Sanitary District Sewage Treatment Plant serves the waste water needs of the City of Clinton. In the region, rural communities generally have private wells for water and septic systems for sanitary wastes. Larger communities obtain water from groundwater extraction wells or lakes and are served by public waste water treatment systems. Exelon performed a survey of water and waste water facilities in the region and found that the facilities have excess capacity to accommodate potential population increases (Exelon 2006a). An independent analysis conducted by the NRC staff confirms Exelon’s conclusion (see Tables 2-19 and 2-20).

Construction Impacts at the Proposed Site

Public water supply and waste water treatment are not a constraint to growth in the vicinity and region of the Exelon ESP site, assuming that growth increases hold to the historical norm. Should there be a disproportionate increase in the populations of Clinton, Monticello, and Farmer City as a result of construction, there could be some capacity constraints. The small number of vacant and rental housing units available in these three areas, however, would constrain water supply and treatment usage. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of construction of a new nuclear unit on water and waste water treatment facilities would be SMALL and that mitigation would not be warranted.

Police, Fire, and Medical Facilities

Within a 16-km (10-mi) radius of the ESP site, there is one fire department, the sheriff's department of DeWitt County, and the City of Clinton police force. In the region, there are a total of 89 fire departments and 75 police departments. Outside the major cities of the area, communities typically share fire-fighting services (Exelon 2006a).

Within a 16-km (10-mi) radius of the proposed ESP site, there are two nursing homes and one hospital serving Clinton. Within the region (80 km [50 mi]), there are 52 hospitals and 84 nursing homes. Exelon concludes that the projected capacity of public services is adequate and is expected to expand modestly to meet the demands of a slight population growth (Exelon 2006a). Annual population growth projections of 0.8 percent or less per year (between 2000 and 2020) would tend to support their conclusion (see Table 2-8). Exelon plans to employ its own security force for a new nuclear unit at the ESP site (Exelon 2006a).

The construction workforce is generally considered to come from within the region; hence, the demand for services would be on established entities, which could provide adequate service to the existing and small increases in population expected in the future. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of a new nuclear unit on police, fire, and medical facilities would be SMALL and that mitigation would not be warranted.

Social Services

This section focuses on the potential impacts of construction on the social and related services provided to disadvantaged segments of the population in DeWitt and Logan Counties. This section is distinguished from issues surrounding environmental justice, which is discussed in more depth in Section 4.7.

Generally, construction of the new units at the Exelon ESP site would be viewed as beneficial economically to the disadvantaged population segments served by the Departments of Human Resources for DeWitt, Piatt, and Logan Counties. Construction of a new nuclear unit might enable the disadvantaged to improve their social and economic position by having construction jobs. At a minimum, the expenditures of the construction workforce in the counties for food and services would have a multiplier effect and increase the number of jobs that could be filled by the disadvantaged. Because it might take some time to get hired, there might be an increased demand for social services for construction workers newly moving to the area and looking for work either at the ESP construction site or in secondary jobs created by the construction.

Summary of Public Services

In summary, public water supply and waste water treatment are not a constraint to growth in the vicinity and region of the ESP site, assuming that growth increases hold to the historical norm. Because the construction workforce is generally considered to come from within the region, the demand for police, fire, and medical services would impact established entities, which could provide adequate service to the existing population and the small increases in population expected in the future. The construction of the ESP facility would have a beneficial economic impact to the economically disadvantaged population, which should lessen the demand for social services. There could be an initial increase in demand for social services at the beginning of the construction period, but this is considered manageable. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of construction of a new nuclear unit on the demand for social and related services would be SMALL and that mitigation would not be warranted.

4.5.3.7 Education

Exelon undertook a survey of class size of some schools within the region and found that of those districts surveyed (a total of 69), 67 percent of the schools have class sizes at or below the national average (Exelon 2004, 2006a). From this, Exelon concludes that there is sufficient capacity for a small increase in school population. The Blue Ridge and Clinton school districts, based in DeWitt County, were not included in the Exelon survey.

NRC staff interviews of the superintendents of the Clinton and Monticello school districts indicated that an increased number of students per classroom was not an issue,[a] which, at least locally around the Exelon ESP site, tends to support Exelon's conclusions.

The majority of the construction workers would be expected to come from the region, with little anticipated in-migration of construction workers from outside the region. Should there be construction workers coming from outside the region, chances are they would commute to the

(a) Personal interviews conducted on March 3, 2004 in the City of Clinton with Roger A. Little, Superintendent, Clinton Unit School District 15, and on March 5, 2004 in the City of Monticello with Lawrence J. McNabb, 2004, Superintendent, Monticello Community School District 25.

construction site, stay for the week, and return to their permanent residences on the weekends. If that is the case, there would be minimal impact of additional children being placed in the educational systems within the region. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of construction of a new nuclear unit construction on education would be SMALL and that mitigation would not be warranted.

4.6 Historic and Cultural Resources

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966, as amended through 2000 (NHPA), also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (such resources are referred to as "Historic Properties" in NHPA). As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC coordinated compliance with Section 106 of the National Historic Preservation Act in meeting the requirements of NEPA.

Construction, operation, and decommissioning of new power units can affect either known or undiscovered cultural resources. Therefore, in accordance with the provisions of NHPA and NEPA, the NRC is required to make a reasonable and good faith effort to identify historic properties in the area of potential effect (APE) and, if present, determine if any significant impacts are likely to occur. Identification is to occur in consultation with the State Historic Preservation Officer, American Indian Tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, if no historic properties (i.e., places eligible for listing on the National Register of Historic Places) are present or affected, the NRC is required to notify the State Historic Preservation Officer before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve adverse effects of the undertaking.

For specific historic and cultural information on the Exelon ESP site, see Section 2.9.

In conducting its analysis of potential impacts to cultural resources from construction at the Exelon ESP site, the NRC defined an APE as the area that includes the ESP unit and its immediate environs. The APE is that area that might be impacted by the construction and operation of a new nuclear unit and construction and operation of new transmission line rights-of-way that might follow, parallel with some of the existing transmission line rights-of-way, now serving the CPS unit. Because laydown yards and, in some cases, associated infrastructure have yet to be identified, the APE is that area within the current CPS site boundary. Disturbed areas within the APE are considered because the extent of disturbance in many areas is not known.

Exelon has indicated that construction of the additional ESP unit would involve land disturbance within a designated site (a previously disturbed area), the ESP cooling tower area, and areas designated for support facilities for functions such as water intake and outfalls. The area designated for the cooling towers and associated infrastructure exhibits less previous ground disturbance than the area where the ESP unit would be constructed. Additionally, temporary parking, module fabrication areas, and laydown zones would involve some ground disturbance. Following construction activities, disturbed support areas would be landscaped and replanted to match the overall site appearance.

As explained in Section 2.9.2, previous cultural resource identification efforts indicated the presence of several archaeological sites and the potential for additional sites, primarily in the areas associated with the construction of the cooling towers. Before construction, consultation by the applicant with the Illinois Historic Preservation Agency would identify any protective measures that should be taken (Exelon 2006a). Possible measures might include methods such as tilling, surveying, and shovel testing. One area of potential concern is the area adjacent to a new water intake structure, where the National Register-eligible Pabst Site (IIDW32) was located. Although the site was excavated in the 1970s and impacted by the original construction of the CPS unit, some remnants of the site may still exist under fill or within the lake (Lewis 1976).

To date, literature reviews and consultations with regional American Indian Tribes have not identified any traditional cultural properties in the vicinity of the proposed construction area of the ESP unit.

No analysis of cultural and historic resources was conducted for the transmission line rights-of-way. The full extent of potential land-use impacts in the transmission line rights-of-way can be estimated only after following the FERC process for connecting new large generation sources to the grid. This process is detailed more specifically in Section 3.3. Once this process is completed, the appropriate cultural resource studies will be undertaken to ensure that resources are identified and addressed before construction. In addition, consultation by the applicant with the State of Illinois would establish requirements to follow should archaeological, historical, or other cultural resources be uncovered during construction (Exelon 2006a).

Based on (1) the pre-construction and construction measures that Exelon would take to avoid adverse impacts to significant cultural resources and (2) the staff's cultural resource analysis and consultation, it is the staff's conclusion that the potential impacts on historic and cultural resources would be SMALL. Mitigation might be warranted in the event of an inadvertent discovery.

4.7 Environmental Justice Impacts

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040; NRC 2004). Figures 2-6 and 2-7 (Section 2.10) show the locations of minority and low-income populations around the Exelon ESP site and within the 80-km (50-mi) radius of the region.

The staff identified the pathways through which the environmental impacts associated with construction of a new nuclear unit at the ESP site could affect human populations. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. During its March 2004 site audit, the staff interviewed local government officials and the staff of social welfare agencies concerning potentially disproportionate impacts to minority and low-income populations. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately impacted by construction of a new nuclear unit and that would result in those populations being adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting minority and low-income populations.

Based on the information provided by Exelon and the staff's independent review, the staff concludes that offsite impacts of construction of a new nuclear unit at the Exelon ESP site to minority and low-income populations would be SMALL and that additional mitigation would not be warranted.

4.8 Nonradiological Health Impacts

Exelon (2006a) indicated that the physical impacts of construction, including public health, occupational health, and noise, would be small and were discussed qualitatively. The area around the Exelon ESP site is predominantly rural with a population of approximately 12,400 people within 16 km (10 mi) of the site. No significant industrial or commercial facilities are currently located or planned in this area. The following sections discuss the results of the staff's assessment of nonradiological health impacts for the ESP site.

4.8.1 Public and Occupational Health

Public Health

Exelon stated in its ER that the physical impacts to the public from construction at the ESP site might include dust, smoke, engine exhaust, and concrete operations as sources of air pollution during site preparation and redress. Exelon stated that operational controls would be imposed to mitigate dust emissions, employing such methods as providing good drainage and dry weather wetting, seeding bare areas to provide ground cover, and paving most traveled construction roads. The concrete facility would be equipped with dust-control systems to minimize releases of concrete dust (Exelon 2006a). Dust generated by construction activities is exempt from State permit requirements pursuant to Illinois Administrative Code 35 IAC 201.146tt.

Engine exhaust would be minimized by maintaining fuel-burning equipment in good mechanical order. Exelon (2006a) stated that applicable air-pollution control regulations would be adhered to as they relate to open burning or the operation of fuel-burning equipment to reduce smoke. Permits and operating certificates would be secured where required.

The public would not be close to the construction site. The nearest residence is 1.2 km (0.73 mi), and the nearest campground, church, and school are 1.6 km (1 mi), 6.1 km (3.8 mi), and 7.7 km (4.8 mi) respectively, from the Exelon ESP site (Exelon 2006a). Based on the mitigation measures identified by Exelon in its ER, the permits and authorizations required by State and local agencies, and the staff's independent review, the staff concludes that the nonradiological health impacts to the public from construction activities would be SMALL and that additional mitigation beyond the actions stated above would not be warranted.

Site Preparation Worker Health

In general, human health risks for construction workers and personnel working onsite would be expected to be dominated by occupational injuries (e.g., falls, electrocution, asphyxiation) to workers engaged in activities such as construction, maintenance, and excavation. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards, practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks associated with construction. The staff assumes strict adherence to NRC, OSHA, and State safety standards, practices, and procedures during construction activities.

Other nonradiological impacts to construction workers include noise, fugitive dust, and gaseous emissions resulting from construction activities. Mitigation measures discussed in this section

| for the public (e.g., a dust control system on a concrete facility) would also help limit exposure to construction workers. Onsite impacts to construction workers would also be mitigated through training and use of personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care and regular health and safety monitoring of construction personnel could also be undertaken.

Based on mitigation measures identified by Exelon in its ER, on permits and authorizations required by State and local agencies, and on the staff's independent review, the staff concludes that the nonradiological health impacts to workers from construction activities would be SMALL and that additional mitigation beyond the actions stated above would not be warranted.

4.8.2 Noise Impacts

Large construction projects involve many noise-generating activities. Regulations governing noise from construction activities are generally limited to worker health. Federal regulations governing construction noise are found in 29 CFR Part 1910 and 40 CFR Part 204. The regulations in 29 CFR Part 1910 deal with noise exposure in the construction environment, and the regulations in 40 CFR Part 204 generally govern the noise levels of compressors. Illinois noise-control regulations are found in the Illinois Administrative Code, Title 35, *Environmental Protection*, Subtitle H: Noise.

Activities associated with construction of a new nuclear unit at the ESP site would generate noise levels typical of larger construction projects. The PPE indicates that construction noise would be between 76 and 101 decibels at a distance of 15 m (50 ft) from the source. Noise levels for common construction activities are typically about 90 decibels at a distance of 3 m (10 ft). At 30 m (100 ft), the noise level would be about 70 decibels, and at a distance of 300 m (1000 ft), the noise level would be 50 decibels. A 10-decibel decrease in noise level is generally perceived as cutting the loudness in half. A few activities (e.g., jack hammering) have noise levels of about 110 decibels.

Many of the construction activities at the Exelon ESP site would take place near the existing CPS unit. It is unlikely that much of the noise from this location would be discernable at the exclusion area boundary or offsite. A 90-decibel noise at the center of the exclusion area would decrease to less than 40 decibels at the nearest residence, and a 110-decibel noise would decrease to about 60 decibels. The nearest school, almost 8 km (5 mi) from the site, would not be impacted by construction noise.

Construction activities would be expected to take place 24 hours per day, 7 days per week.
| However, the ER (Exelon 2006a) lists a number of measures that would be taken to mitigate the potential adverse effects of construction noise. Among the mitigation measures are compliance with Federal and State regulations, use of standard noise-control devices,

development of a hearing conservation program, and limitation of activities with significant noise impacts to weekdays.

Considering the temporary nature of construction activities and the location of the Exelon ESP site, the staff concludes that the noise impacts from construction would be SMALL and that further mitigation beyond that discussed above would not be warranted.

4.8.3 Summary of Nonradiological Health Impacts

The staff reviewed the information in the Exelon ER (Exelon 2006a) and concludes that nonradiological health impacts to construction workers, workers at the current Clinton Power Station facility, and the local population from fugitive dust, occupational injuries, and noise would be SMALL, and additional mitigation is not warranted.

4.9 Radiological Health Impacts

The sources of radiation exposure for construction workers include direct radiation exposure, exposure from liquid radioactive waste discharges, and exposure from gaseous radioactive effluents from the existing CPS unit during the site-preparation and construction phase. For the purposes of this discussion, construction and site preparation workers are assumed to be members of the public, and therefore, the dose estimates are compared to the dose limits for the public, pursuant to 10 CFR 20, Subpart D. Exelon (2006a) noted that all major construction activities are expected to occur outside the CPS protected area boundary but inside the restricted area boundary, as shown in Figure 4-2.

4.9.1 Direct Radiation Exposures

In its ER, Exelon identified two sources of direct radiation exposure from the CPS: (1) the cycled condensate storage tank located at the northern boundary of the protected area adjacent to the existing switchyard, and (2) skyshine from the nitrogen-16 activity present in the reactor steam in the high-pressure and low-pressure turbines, the intercept valves, and the associated piping located on the main floor of the turbine building (Exelon 2006a). The staff did not identify any additional sources of direct radiation during the site visit or during document reviews.

Exelon used fenceline thermoluminescent dosimeters (TLDs) and environmental TLDs to measure direct radiation levels at locations in and around the CPS protected area (Exelon 2006a). Eleven fenceline TLDs are located along the protected area fence. The protected area fenceline is shown in Figure 4-2. Environmental TLDs are located in two rings around the CPS, an inner ring near the site boundary, and an outer ring about 8 km (5 mi) from the plant (AmerGen 2002b). All these TLDs are read quarterly and measure any contribution to

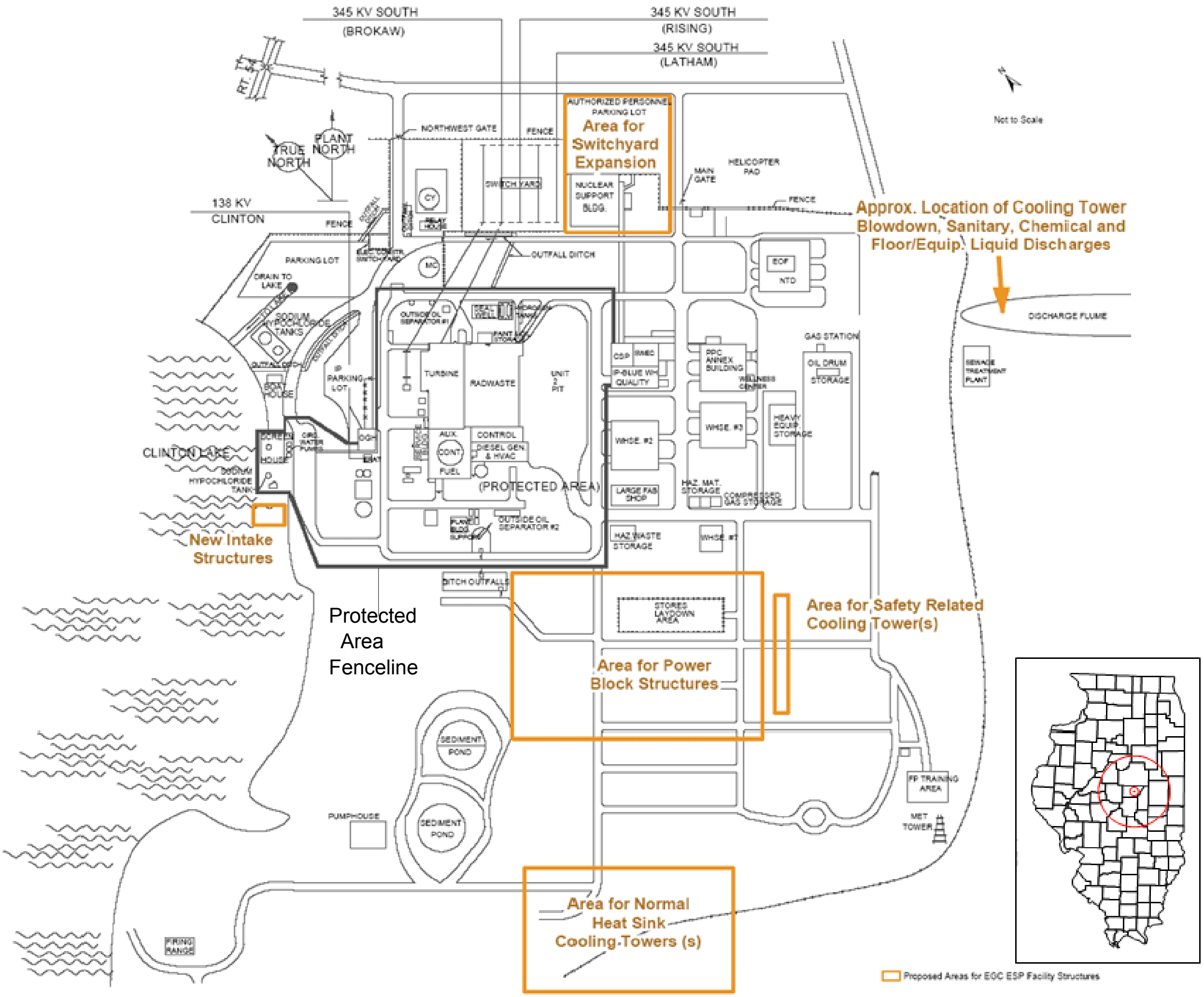

Figure 4-2. Location of Exelon ESP Structures Relative to Existing CPS Facility

dose from the cycled condensate storage tank and skyshine from nitrogen-16 activity present in the turbine buildings.

For 2001, the average quarterly reading for the inner- and outer-ring environmental TLDs was 0.181 mSv (18.1 mrem) with measurements ranging from 0.131 to 0.219 mSv (13.1 to 21.9 mrem) (AmerGen 2002b). This compared to average quarterly readings from control locations of 0.169 mSv (16.9 mrem) with measurements ranging from 0.150 to 0.195 mSv (15.0 to 19.5 mrem) (AmerGen 2002b). AmerGen concluded that these results were not significantly different and showed no increase in environmental gamma radiation levels resulting from plant operations at the CPS. Similar results were observed for the past several years (AmerGen 2000a, 2001b, 2003).

Exelon estimated direct radiation exposure to construction workers by using protected area fenceline TLD measurements. The average quarterly readings for the fenceline TLDs for a 2-year period (second quarter 2001 to first quarter 2003) was 0.265 mSv (26.5 mrem). This corresponds to a dose rate of 0.121 µSv/hr (12.1 µrem/hr). A construction worker present for 2080 hours per year in a dose rate field of 0.121 µSv/hr (12.1 µrem/hr) would receive an annual dose of 0.25 mSv (25 mrem) (Exelon 2006a). The Exelon construction worker dose estimate is conservative for the following reasons: (1) the fenceline TLD readings on the south side of the protected area closest to the new nuclear unit were lower than the average of all the values (i.e., using the TLD results from the south side of the protected area only would result in an estimated annual dose to the construction worker of only 0.14 mSv [14 mrem]), (2) dose rate estimates were adjusted to consider the reactor operating 100 percent of the time, and (3) adjustments to subtract out background radiation were not made. AmerGen (2002b) reported an average quarterly background reading of 0.169 mSv (16.9 mrem). Adjusting for worker occupancy, a construction worker would get approximately 0.16 mSv (16 mrem) annually from natural background.

4.9.2 Radiation Exposures from Gaseous Effluents

The CPS releases gaseous effluents via the common station heating, ventilating, and air conditioning stack and the standby gas treatment system vent. Exelon (2006a) estimated construction worker dose from gaseous effluents by taking the dose estimates to the maximally exposed member of the public from the *Annual Radioactive Effluent Release Report* (AmerGen 2002a). The highest annual dose to a member of the public from gaseous effluents was 3×10^{-5} mSv (0.003 mrem) to an individual using the public access road in the southeast sector of the site within the CPS site boundary. This dose was based on an occupancy of 243 hr/yr (Exelon 2006a), which represents the estimated amount of time a member of the public would spend on the public access road annually. Adjusting this dose for the expected occupancy of a construction worker (i.e., 2080 hours per year), the annual dose from gaseous effluent releases becomes 3×10^{-4} mSv (0.03 mrem). A review of annual effluent release reports for the past several years showed this dose to be typical. The dose to construction workers from the gaseous effluent releases would be negligible compared to the dose from direct radiation exposure.

4.9.3 Radiation Exposures from Liquid Effluents

Exelon considered radiation exposures from liquid effluents to be negligible for estimating dose to construction workers (Exelon 2006a). The CPS has not released any liquid radioactive effluents to the environment since 1992 (AmerGen 2002a). A review of radioactive effluent release reports for the past several years confirmed that there have been no radioactive liquid effluents released from CPS in recent years (AmerGen 2000b, 2001a, 2002a).

4.9.4 Total Dose to Site-Preparation Workers

Exelon has estimated an annual dose to a site-preparation worker of 0.25 mSv (25 mrem) from the direct radiation pathway. Doses from liquid and gaseous effluent releases are negligible compared to the dose from direct radiation. The annual dose estimate for the site preparation workers was approximately 0.25 mSv (25 mrem) which is less than the 1 mSv (100 mrem) annual dose to an individual member of the public found in 10 CFR 20.1301. If the dose estimate had exceeded 100 mrem annually, the site preparation workers would need to be treated as radiological workers and would be subject to the annual occupational dose limit of 0.05 Sv (5 rem) found in 10 CFR 20.1201.

The maximum estimated annual collective dose to site-preparation workers, based on an annual individual dose of 0.25 mSv (25 mrem) and an estimated workforce of 3150 workers, is 0.80 person-Sv (80 person-rem).

4.9.5 Summary of Radiological Health Impacts

Having reviewed Exelon's estimate of dose to site preparation workers during construction activities, the staff found the doses to be well within NRC exposure limits designed to protect the public health, even if workers exceeded the 2080 hr/yr occupancy factor. Assuming the location of the proposed new nuclear unit does not change, the staff concludes that the impacts of radiological exposures to site preparation workers would be SMALL and that no mitigation would be warranted.

4.10 Measures and Controls to Limit Adverse Impacts During Site-Preparation Activities

The following measures and controls would limit adverse environmental impacts:

- Compliance with applicable Federal, Illinois, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emissions, noise control, storm water management, spill response and cleanup, hazardous material management)

- Compliance with applicable requirements of existing permits and licenses (e.g., the IEPA/NPDES Permit and the Operating License) for the existing units and other permits or licenses required for construction of the new units (e.g., ACE Section 404 Permit, Illinois Department of Environmental Quality wetlands permit)

- Compliance with existing Exelon processes and/or procedures applicable to construction environmental compliance activities for the Exelon ESP site (e.g., solid waste management, hazardous waste management, and spill prevention and response)

- Incorporation of environmental requirements into construction contracts

- identification of environmental resources and potential impacts during the development of the ER and the ESP process.

4.11 Site Redress Plan

Site-Preparation and Preliminary Construction Activities

Exelon requested that it be allowed to conduct site-preparation activities at the ESP site as authorized by 10 CFR 52.17(c), 10 CFR 52.25, and 10 CFR 50.10(e)(1). Exelon stated that it might choose to perform none, some, or all of the activities described in Section 1-3 of the site redress plan (Exelon 2006a). Exelon included in its application, as required by 10 CFR 52.17(c), a site redress plan that would be implemented if site-preparation activities were performed, should the ESP expire before the issuance of a CP or COL by the NRC (Exelon 2006b). The objective of the site redress plan is to ensure that the ESP site would be returned to an environmentally stable and aesthetically acceptable condition suitable for non-nuclear uses consistent with DeWitt County zoning requirements. Under the site redress plan, areas that were permanently disturbed would be stabilized and contoured to conform to surrounding areas. Revegetation of disturbed lands would be conducted.

Construction Impacts at the Proposed Site

Prerequisites of site-preparation activities that must be fulfilled before performing such activities include:

- Documentation of existing site conditions within the Exelon ESP site by way of photographs, surveys, listings of existing facilities and structures, or other documentation — This record would serve as the baseline for redressing the site in the event ESP site-preparation activities were terminated as a result of project cancellation or expiration of the ESP.

- Coordination of the movement of the existing CPS protected area boundary, as required — These activities would be coordinated with the CPS to accomplish the movement of structures reflected in the CPS licensing basis in a manner consistent with its operating license and the applicable regulations governing that license.

- Movement, demolition, or ownership transfer of existing CPS buildings and structures within the Exelon ESP site — These activities will be coordinated with the CPS to accomplish the movement, demolition, or ownership transfer of structures reflected in the CPS licensing basis in a manner consistent with its operating license and the applicable regulations governing that license.

- Obtaining the necessary permits to perform preconstruction activities, such as local building permits, IEPA NPDES permit, IEPA CWA permit, IEPA General Storm Water Permit, etc.

After these prerequisites were completed, planned site-preparation activities could proceed and might include none, some, or all of the following activities pursuant to 10 CFR 52.17(c) and 10 CFR 50.10(e)(1). In the ESP application, Exelon requested approval to perform the following site-preparation activities for a new nuclear unit at the ESP site (Exelon 2006a):

- Prepare the site for construction of the facilities (including such activities as clearing, grading, construction of temporary access roads, and preparation of borrow areas)

- Install temporary construction support facilities (including items such as warehouses, shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings)

- Excavate for facility structures

- Construct service facilities (including items such as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, transmission lines[(a)], and sanitary sewage treatment facilities)
- Drill sample/monitoring wells or additional geophysical borings
- Construct structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public, including but not limited to

  - cooling towers
  - intake and discharge structures
  - circulating water lines
  - fire protection equipment
  - switchyard and onsite interconnections
  - transmission system[(a)]
  - underground utilities.

The environmental impacts of site-preparation activities allowed pursuant to 10 CFR 50.10(e)(1) are bounded by environmental impacts for construction of the entire facility. In many cases, the impacts of site-preparation activities and construction may be similar, but the impacts resulting solely from site-preparation activities would be of a shorter duration. In the preceding sections in this chapter, the staff has presented impacts of construction that bound the impacts of site preparation. If the ESP expires before an application for a CP or COL is received under 10 CFR Part 52, Subpart C, and site-preparation activities have occurred, the site redress plan would be activated to return the ESP site to an environmentally stable and aesthetically acceptable condition suitable for future alternative use (presumably non-nuclear) that conforms to local zoning laws, thus minimizing the long-term environmental impacts.

Site Redress Plan

Exelon provided a site redress plan as part of its ESP application in the event that site-preparation work did not proceed to full construction (Exelon 2006b). The plan identifies the overall objective as providing “an environmentally stable, self-draining, self-maintaining, esthetically acceptable site that can be left unattended.” In its plan, Exelon states that redress

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(a) As discussed in Section 3.3 of this EIS, Exelon has not submitted an Interconnection Request to AmerenIP. The process for obtaining transmission services discussed in that section would have to be completed before construction of the transmission lines could begin.

activities would reflect applicable land-use and zoning requirements and identifies the following five general redress activities for consideration:

- Recontouring, revegetation, and replanting of cleared areas
- Restoration of sensitive water resource features disturbed for intake and/or discharge structures
- Habitat replacement
- Use of constructed facilities for alternative purposes, or their removal
- Remediation of contamination resulting from site-preparation or site redress activities.

The staff has reviewed the list of allowed site-preparation activities in the event that the ESP is granted and has reviewed the full site redress plan submitted by Exelon. As a result of its own independent review, the staff, in accordance with 10 CFR 52.25(a), concludes that the potential site-preparation activities described in Exelon's site redress plan would not result in any significant adverse environmental impacts that could not be redressed.

4.12 Summary of Construction Impacts

Impact level categories are denoted in Table 4-1 as SMALL, MODERATE, or LARGE as a measure of their expected adverse environmental impacts, if any. A brief statement explains the basis for the impact level. Some impacts, such as the addition of tax revenue from Exelon for the local economies, are likely to be beneficial impacts to the community.

Impacts related to terrestrial ecology were estimated for the purpose of comparison to alternatives, but the issue is unresolved because significant information on the proposed action is lacking at the ESP stage. An applicant for a CP or COL that references the Exelon ESP would need to provide this information to enable analysis at that time.

4.13 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

Table 4-1. Characterization of Impacts from Construction of a New Nuclear Unit at the Exelon ESP Site

Category	Comments	Impact Level
Land-Use Impacts		
Site and Vicinity	Construction activities would take place within existing site boundaries.	SMALL
Transmission Line Rights-of-Way and Offsite Areas	Existing rights-of-way likely to be expanded.	SMALL
Meteorological and Air Quality Impacts		
Construction Activities and Transportation	Construction activities would be conducted in accordance with applicable State administrative codes, and dust and emissions would be minimized through a dust control plan. Air quality would not be degraded sufficiently to be noticeable beyond the immediate vicinity.	SMALL
Water-Related Impacts		
Hydrological Alterations	Impacts localized and temporary. IEPA 401 permit process will be adequate to ensure impacts will be SMALL.	SMALL
Water Use	Dewatering may cause localized declines in the water table. Water needed for construction activities will be far less than the consumptive water loss from a wet tower.	SMALL
Water Quality	Construction would be conducted using best management practices to control spills and storm water runoff.	SMALL
Ecological Impacts		
Terrestrial Ecosystems	Construction within or adjacent to existing rights-of-way would likely have minimal impacts on terrestrial species and habitat. Up to LARGE impacts for construction of new rights-of-way.	Unresolved, likely to be SMALL
Aquatic Ecosystems	Construction activities would have minimal impact to aquatic ecological resources and habitat.	SMALL
Threatened and Endangered Species	Construction impacts to Federally listed species are expected to be negligible.	SMALL
Socioeconomic Impacts		
Physical Impacts		
Workers/Local Public	Impacts to the public would be minimal due to construction activities taking place within existing plant boundaries.	SMALL
Buildings	Construction would not affect any offsite buildings.	SMALL
Roads	Construction traffic could physically impact the road system, particularly heavy truckloads of construction equipment. These impacts could be mitigated by upgrading the rail line into the CPS site.	SMALL to MODERATE
Aesthetics	Construction activities would be temporary, and observation points would be limited because of site location.	SMALL
Demography	Percentage of construction workers relocating to the region would be small. Most would already live within the region.	SMALL

Table 4-1. (contd)

Category	Comments	Impact Level
Impacts to Community - Social and Economic		
Economy	Economic impacts of construction overall are beneficial to local economies. DeWitt County impacts may be MODERATE.	Beneficially SMALL to MODERATE
Taxes Income Taxes Sales and Use Taxes Property Taxes	Generally, impacts are beneficial to State and local governments. DeWitt County impacts may be MODERATE.	Beneficially SMALL to MODERATE
Impacts to Community - Infrastructure and Community		
Transportation	Roads are lightly traveled and, except at shift changes, would not be overly congested by increased construction traffic. If congestion does occur or is anticipated, mitigation measures can be undertaken.	SMALL
Recreation	Recreational impacts would be minimal and temporary during construction activities.	SMALL
Housing	Rental property is scarce near the ESP site, but found near larger cities. Generally, there is sufficient housing to meet the demands put on the housing system by construction workers if they live in the larger cities. There could be greater impact if the worker choose to live in DeWitt, Logan, or Piatt counties.	SMALL to MODERATE
Public Services	Public services are adequate for any temporary influx of workers due to the construction at the ESP site. Construction may lessen the demand for social services due to beneficial economic impacts.	SMALL
Education	Majority of construction workers are expected to already live in the region.	SMALL
Historic and Cultural Resources	Proposed construction area is previously disturbed, except where cooling towers might be built. Exelon would need to consult with IHPA at the CP or COL stage. Exelon has committed to develop procedures to manage cultural resources in the event of an inadvertent discovery.	SMALL
Environmental Justice	No unusual resource dependencies in the area.	SMALL
Nonradiological Health Impacts	Emission controls and remote location of the ESP site would keep nonradiological health impacts small. Adherence to Federal and State Regulations assumed to protect occupational workers.	SMALL
Radiological Health Impacts	Exposures would be below annual occupational and public dose limits.	SMALL

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

18 CFR Part 35. Code of Federal Regulations, Title 18, *Conservation of Power and Water Resources*, Part 35, "Filing of Rate Schedules and Tariffs."

29 CFR Part 1910. Code of Federal Regulations, Title 29, *Labor*, Part 1910, "Occupational Safety and Health Standards."

29 CFR Part 1926. Code of Federal Regulations, Title 29, *Labor*. Part 1926, "Safety and Health Regulations for Construction."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 204. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 204, "Noise Emission Standards for Construction Equipment."

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5.0 Station Operation Impacts at the Proposed Site

This chapter examines environmental issues associated with operation of the proposed new nuclear unit at the early site permit (ESP) site to be located adjacent to the Clinton Power Station (CPS), for an initial 40-year period as described by Exelon Generation Company, LLC (Exelon). As part of this application, Exelon submitted an Environmental Report (ER) that discussed the environmental impacts of station operation (Exelon 2006a). This chapter is divided into 13 sections. Sections 5.1 through 5.11 discuss the potential operational impacts on land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the Code of Federal Regulations (CFR), Part 51, impacts have been analyzed and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned to each analysis. In the area of socioeconomics related to taxes, the impacts may be considered beneficial and are stated as such. The staff's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State and county governments, such as infrastructure upgrades, as discussed throughout this chapter, are implemented. Failure to implement these upgrades might result in a change in significance level. Possible mitigation of adverse impacts is also presented, where appropriate. Negligible impacts are categorized as SMALL impacts. Beneficial impacts are categorized as a range from SMALL, MODERATE to LARGE. A summary of these impacts is presented in Section 5.12. The references cited in this chapter are listed in Section 5.13. For issues that are considered resolved under 10 CFR 52.39(a)(2), the staff will verify the continued applicability of all assumptions used in its environmental analysis, should an applicant for a CP or COL reference the Exelon ESP.

5.1 Land-Use Impacts

Sections 5.1.1 and 5.1.2 contain information regarding land-use impacts associated with operation of a new nuclear unit at the Exelon site. Section 5.1.1 contains a discussion of land-use impacts at the site and in the vicinity of the site. Section 5.1.2 contains a discussion of land-use impacts in transmission line rights-of-way and offsite areas.

5.1.1 The Site and Vicinity

Based on the information provided by Exelon and the staff's independent review, the staff concludes that the operation of the proposed unit at the ESP site may result in the need for more local housing in the vicinity, which could have SMALL land-use impacts associated with land conversion to residential use. Such impacts are not certain and would result from changes in socioeconomic conditions, as described in Section 5.5.

Based on information presented in Section 5.5.2, the staff finds that relocating workers would tend to seek housing where it is currently most available and where the choice of homes is greatest, such as Decatur, Bloomington-Normal, or Champaign-Urbana. If workers relocate in proportion to the current distribution of worker residences, increased demand for housing in DeWitt County would lead to minimal land use impacts associated with new housing construction. It is not possible to know what real estate or land development might occur in DeWitt County as a result of siting and operating the new nuclear unit at the ESP site. Therefore, the staff concludes that land-use impacts from development of new housing would occur, but such impacts would be widely disbursed and would not be concentrated in any one community. Such impacts might include land-cover alteration on private lands, new property access roads, or conversion from private agricultural to residential use.

Adding the new nuclear unit at the Exelon ESP site to the current CPS site would introduce staggered refueling and maintenance outages. It is likely that outages would be scheduled for one facility at a time, increasing the frequency of the need for temporary outage workers (1300 workers during CPS outages and 1000 workers during ESP facility outages) (Exelon 2006b). This increase in frequency would lead to increased impacts at local campgrounds and other local temporary housing facilities in the vicinity on a sustained basis. However, these impacts would not be expected to noticeably alter current land uses in the vicinity.

Another potential impact to land use includes the effects of salt drift on crops, timber, and other vegetation from operation of wet cooling towers (either natural or mechanical draft) that are included in the plant parameter envelope (PPE) for a new nuclear unit at the Exelon ESP site. Crops would be in the path of vapor plumes carried on northerly or westerly winds and could thus be affected by salt drift. It is assumed that new cooling towers would produce salt concentrations similar to cooling towers at existing nuclear power plants. New cooling towers would be located WSW of the ESP unit. The impact of salt drift on crops, ornamental vegetation, and native plants was evaluated for existing nuclear power plants in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, (NRC 1996 and 1999[a]) and was found to be of minor significance. This determination also included existing nuclear power plants with more than one cooling tower. Consequently, damage to timber or crops from the operation of cooling towers for the Exelon ESP facility would be negligible.

Impacts to land use that would occur include minor land cover alterations because of the geographically disbursed construction of new housing for ESP unit workers. Therefore, the staff concludes that land-use impacts in the vicinity of the ESP unit due to operations would be SMALL, and additional mitigation would be warranted.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

5.1.2 Transmission Line Rights-of-Way and Offsite Areas

In its ER, Exelon states that the transmission owner would conduct two types of activities as part of normal transmission line maintenance and in accordance with existing right-of-way agreements with landowners. These include routine vegetation clearing activities and access road construction for temporary maintenance needs. Exelon assumes these activities would be carried out in consultation with affected landowners (Exelon 2006a). In the event that upgraded transmission lines are constructed in the existing transmission line rights-of-way, the staff finds that only SMALL impacts to land use would occur as a result of normal transmission maintenance activities such as right-of-way vegetation clearing, line maintenance, and other normal access needs.

5.2 Meteorological and Air Quality Impacts

Sections 2.3.1 and 2.3.2 contain a discussion of the meteorological characteristics and air quality of the Exelon ESP site. The primary impacts of operation of a new nuclear unit on local meteorology and air quality would be from releases to the environment of heat and moisture from the primary cooling system (cooling towers), operation of auxiliary equipment (generators and boilers), and emissions from workers' vehicles. The potential impacts of releases from operation of the cooling system are discussed in Section 5.2.1. Section 5.2.2 covers potential air quality impacts from nonradioactive effluent releases at the ESP site, and Section 5.2.3 covers the potential air quality impacts of transmission line rights-of-way during plant operation.

5.2.1 Cooling Tower Impacts

The proposed cooling system for a new nuclear unit at the Exelon ESP site is a wet cooling tower with a hybrid wet/dry cooling system as an alternative. The most apparent impacts of wet cooling towers are the land-use and aesthetic impacts associated with visible plumes. The air quality impacts of wet cooling towers are associated with the drift from the cooling towers and possible interactions between the moist plumes and other pollutants. Existing wet cooling towers at nuclear plants have drift eliminators to reduce drift. The use of hybrid wet/dry cooling towers at a new nuclear unit could reduce potential impacts of wet cooling towers and reduce the amount of water vapor and drift of the plume.

Drift comprises small water droplets that are carried out of the cooling tower. These droplets evaporate, leaving particles that contain residual salts and chemicals from the cooling water. Drift from mechanical draft cooling towers is deposited near the cooling tower, and drift from natural draft towers is deposited farther downwind. Based on a review of the measurements of deposition of drift from nuclear power plants in NUREG-1437, the staff found that "...measurements indicate that, beyond about 1.5 km (1 mile) from the nuclear plant cooling tower, salt deposition is not significantly above background levels" (NRC 1996).

There are no major air pollution sources near the Exelon ESP site. Diesel generators and boilers at the CPS operate for limited periods; generators and boilers that would be associated with a new nuclear unit would also be operated for limited periods. Interactions between pollutants emitted from these sources and the plumes from the cooling towers for a new nuclear unit would be intermittent and would not have a significant impact on air quality.

Based on the above considerations and the assumption that cooling towers associated with a new nuclear unit would be similar to cooling towers at existing nuclear plant sites, the staff concludes that cooling tower impacts on air quality would be SMALL and that additional mitigation of air quality impacts would not be warranted. The CPS does not use wet cooling towers, and there are no other cooling towers in the immediate vicinity of the ESP site. Therefore, the staff concludes that there are no cumulative impacts of cooling towers on air quality.

5.2.2 Meteorological and Air Quality Impacts

A new nuclear unit at the ESP site would include additional standby diesel generators and auxiliary power systems for emergency power and auxiliary steam purposes. These systems would be used on an infrequent basis and pollutants discharged (e.g., particulates, sulfur oxides, carbon monoxide, hydrocarbons, and nitrogen oxides) would be in accordance with State and Federal regulatory requirements. Exelon (2006a) provides bounding values for these pollutants. Because these systems would be used on an infrequent basis (i.e., typically a few hours per month) and there would be no significant industrial activities within 16 km (10 mi) of the Exelon ESP site, the staff concludes that the environmental impact of pollutants from these sources would be SMALL and that additional mitigation would not be warranted.

Exelon did not estimate the carbon dioxide emissions from the proposed action. Nuclear power generation by itself does not result in carbon dioxide emissions, and the emissions associated with auxiliary equipment are small because of the intermittent operation of the equipment. However, when the uranium fuel is considered, there are carbon dioxide emissions associated with nuclear power. Table S–3 in 10 CFR 51.51 indicates that the oxides of nitrogen emitted in the fuel cycle are approximately 5 percent of the oxides of nitrogen emitted by a coal-fired plant. Extending this analogy to carbon dioxide and considering advances in fuel cycle technology, the staff estimates that uranium fuel cycle carbon dioxide emissions for the postulated plant would be less than 0.8 million metric tons (0.9 million tons).

5.2.3 Transmission Line Impacts

Impacts of existing transmission lines on air quality are addressed in the GEIS (NRC 1996). Small amounts of ozone and smaller amounts of oxides of nitrogen are produced by transmission lines. The small amounts of these gases were found to be insignificant for 745-kV lines (the largest lines in operation) and for a prototype 1200-kV line. In addition, it was determined that potential mitigation measures would be very costly and would not be warranted. The largest lines currently used by the AmerenIP transmission system are 345-kV lines (Exelon 2006a), well within the range of lines considered in the GEIS. Therefore, the staff concludes that the potential impacts of transmission lines on air quality are SMALL and that mitigation measures beyond those normally taken in construction and operation of transmission lines would not be warranted.

5.3 Water-Related Impacts

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting, objectives. The objectives of water management at Clinton Lake and Salt Creek downstream of Clinton Lake include recreation, visual aesthetics, a fishery, and a variety of beneficial consumptive uses of water, such as industrial uses (e.g., cooling water for power generation). The responsibility for regulating water use and water quality is delegated to the Illinois Environmental Protection Agency (IEPA) through both Federal laws and laws of the State of Illinois. Water resource management is subject to considerable uncertainty because of the limited ability to reliably predict the future supply of and demand for water that results from natural climate variability. The ability to manipulate the water supply to balance periods of excess water supply with periods of excess water demand is limited by the available water infrastructure. While the water supply is regularly being replenished by precipitation, conflicts over water resources typically grow along with population.

Both Exelon and the staff conducted independent analyses of the changes in Clinton Lake's water supply that would result from operating a new nuclear unit at the Exelon ESP site. These calculations employed different approaches and relied on different data sources. For a more complete description of Exelon's analysis, refer to Sections 5.2.2 and 5.3.2 of the ER (2006a). See Section 2.6 for the staff's description of the hydrologic conditions in the vicinity of the site.

5.3.1 Hydrological Alterations

The reduced volume of water in Clinton Lake, due to the water loss associated with the cooling towers, would result in shorter times for the water to travel from the discharge back to the intake. By reducing the travel time, the average temperature in the lake would increase, thereby contributing to additional induced evaporation in the lake. Based on the relatively one-dimensional flow pattern between the discharge and the intake, the staff concludes that the increase in lake temperatures would advance farther from the discharge towards the intake. However, the impacts of the increased velocities would not be expected to detrimentally impact the lake.

The reduced volume of water in Clinton Lake would decrease the lake's pool elevations and increase the frequency and duration that the releases from Clinton Lake would be at the minimum release level. Exelon's and the staff's independent assessments of this change in the pool elevation and downstream releases are described in the following section.

5.3.2 Water-Use Impacts

The existing CPS unit is one the largest users of water in the region. The ESP site, likewise, would be a major water-user. Most of the CPS water usage is water drawn from Clinton Lake for condenser cooling, which is returned to the lake. However, the existing facility's operation does result in a consumptive water loss as a result of induced evaporation of water from Clinton Lake caused by the increase in the lake's temperature from the once-through cooling discharge. Operations of a new nuclear unit would result in a significant increase in consumption of water.

The impacts on water use are related to the water budget. The consumptive use of water by a new unit would directly reduce the water supply. Additionally, by reducing the lake volume, a new unit would indirectly increase the induced evaporation in Clinton Lake, thereby further reducing the water supply. The reduction in the water supply would result in decreases in the lake's pool elevation and an increase in the frequency and duration of releases from the lake at the minimum release values.

The water budget for Clinton Lake is limited to a relatively small number of inputs and outputs. The fixed weir design of the Clinton Lake dam does not allow for active management of the lake pool levels or downstream releases. Water in excess of the weir height freely spills over the weir and down the spillway. Once the lake pool elevation drops below the weir height, downstream flows are maintained at the release minimums with a submerged pipe and gate with a limited flow capacity. The inputs to the Clinton Lake water budget would include direct precipitation to the lake and surface and subsurface discharges from the contributing watershed. The outputs would include spills over the dam's weir, releases from the dam's release gate, natural evaporation, induced evaporation, and consumptive loss of water from the new nuclear unit's cooling towers. If the sum of the inflows were to exceed the sum of the outflows, the storage in the lake would increase. If the outflows exceed the inflows, the storage in the lake would decrease.

In response to the Nuclear Regulatory Commission's (NRC's) request for additional information (NRC 2004a), Exelon calculated the lake water surface elevation changes for a 24-year period of record from June 1, 1978, to April 31, 2002 (Exelon 2004a). Exelon provided information on the predicted pool elevation if an ESP facility had been operating during this period. Exelon used a water budget approach, wherein the change in lake storage is the result of an imbalance between inflows and outflows. Inflows were considered from direct precipitation onto the lake and upstream drainage. Model outflows were the sum of water passed either over the spillway or through the dam, natural evaporation, and induced plus direct evaporation due to both CPS Unit 1 and the ESP unit.

Both the staff's and Exelon's water budget models of Clinton Lake are based on a simplified representation of the conservation of mass. The principle of conservation of mass can be restated specifically for water as "the change in storage of water at any time is equal to the water inflow less the water outflow." In both water budget models, changes in lake storage over time would be equal to the differences between the inflows and the outflows. Inflows would include the drainage from the basin upstream of the lake and the precipitation occurring directly on the lake. Outflow includes natural, direct and induced evaporation plus releases, either over the spillway or through the dam. Groundwater could either flow from the aquifer into Clinton Lake or from Clinton Lake into the aquifer. Based on groundwater elevation measurements, flow from Clinton Lake into the adjacent subsurface would only occur as the lake level rises after an extended period of low lake level evaluations and would be limited to the soils a short distance from the bank. The change in storage would be reflected by a change in pool elevation.

The staff and Exelon made different assumptions to estimate the inflow to Clinton Lake. Because of the absence of tributary flow measurements, there is no direct way to estimate the total inflow into Clinton Lake from its tributaries. The outflow from Clinton Lake's dam was estimated by Exelon from the U.S. Geological Survey gauge downstream from the dam at Rowell, Illinois, after correcting for the additional contributing area downstream between the dam and the Rowell gauge. Evaporation estimates were based on calculations with Exelon's lake temperature model, discussed in Section 5.2.1 of the ER (Exelon 2006a).

Because historical pool elevation records were not available, the only information available to calibrate the inflow estimates was discharge recorded at the Rowell gauge downstream of the Clinton Dam. For the tributary inflows, Exelon estimated monthly average runoff yield coefficients (ratio of runoff to rainfall), which were multiplied by the recorded rainfall during the period of record to generate a runoff record. By considering only rainfall (excluding snowfall) the approach resulted in conservative annual water yield. However, these estimates would not necessarily provide conservative estimates in warm dry years. Therefore, the staff applied a different approach, estimating inflows by using stream flow data from an adjacent unregulated, undiverted watershed.

The staff found an adjacent streamflow gauge on Kikapoo Creek at Waynesville, IL. The drainage of Kikapoo Creek is adjacent to that of the North Fork of the Salt Creek and is located to the northwest. The Kikapoo Creek gauge at Waynesville is approximately 24.5 km (15.3 mi) from the Clinton Dam. This gauge, which is minimally affected by streamflow regulation, is comparable in size of its contributing area (588 km^2 [227 mi^2]) to that of the drainage area (748.9 km^2 [289.2 mi^2]) that contributes flow to Clinton Lake. To estimate inflows into Clinton

Lake, the staff scaled the stream flow observed at Kikapoo Creek at Waynesville by the ratio of contributing area at Clinton Dam to the contributing area at the Waynesville gauge. The time period used for estimating inflow was January 28, 1948, to September 30, 2001.

The staff and Exelon also made different assumptions as to the consumptive use of water due to the induced evaporation caused by the existing CPS unit. Exelon based its evaluation on the monthly induced evaporation estimates derived in the Updated Final Safety Analysis Report (Exelon 2003). The staff used 80 percent of the bounding value of an equivalent wet tower evaporation rate for the CPS unit at its current rated power. This assumes that 20 percent of the heat would be dissipated by heat transfer processes other than evaporation such as long-wave back radiation and conduction. The staff's estimate of induced evaporation due to the existing CPS unit is significantly greater than the applicant's and is considered very conservative.

The results of the staff's independent analysis show that the additional consumptive water loss of a new nuclear unit's wet cooling tower would result in longer and more frequent periods of minimum releases from Clinton Dam. Based upon 100% unit operation and the 51-year period between 1948 and 1999, the estimated percentage of time that minimum flows would have been released from the dam (i.e., when water surface elevations were below 210 m (690 ft) increased from 43 percent (CPS only) to 68 percent (CPS and ESP unit). The pool elevation would also be lowered due to the consumptive water loss caused by a new nuclear unit. The percentage of time with pool elevations below 207 m (680 ft) and 206 m (677.5 ft) would increase from 0 percent (only the CPS unit) to 9 percent and 5 percent, respectively, if both the CPS and a new nuclear unit were operating. Both of these impacts would be greater in years with lower-than-normal precipitation.

The staff found that the frequency and duration of low water conditions would increase if the ESP unit were constructed. Impacts could be minor during periods with average or above-average precipitation. Therefore, the staff concludes that during normal water years, the water-use impacts would be SMALL and mitigation would not be warranted. During the years of below-average precipitation, the impact level could be MODERATE until normal water conditions return. In such cases, Exelon would need to coordinate with IEPA on appropriate measures, such as derating or even temporary shutdown of the unit.

5.3.3 Water Quality Impacts

Because a specific design has not been selected, the ultimate water treatment systems for a new nuclear unit at the Clinton ESP site have not been specified. Currently, raw cooling water from Clinton Lake for condenser cooling and service water needs is not treated. Makeup water for the new unit and the ultimate heat sink systems would require treatment with biocides, antiscalants, and dispersants. Makeup of ultrapure water systems, such as condensate and primary cooling, would employ technologies such as reverse osmosis and ultrafiltration.

As discussed above, the consumptive water use from a new nuclear unit would reduce the volume of water in the lake during low water periods that is available to absorb the heat rejected by the currently operating CPS. As a result, the temperature of the water in Clinton Lake would increase. This increase in temperature, combined with the increased velocity caused by reduced lake volume, would tend to push the thermal plume farther toward the intake. However, impacts to the lake would be lessened during periods of relative water excess (lake water surface elevations above 210 m [690 ft]) because the lake volume would be approximately the same regardless of ESP unit operation. Exelon has committed to keeping the combined discharge of the CPS and ESP unit effluent within the bounds of the CPS's existing NPDES permit, which IEPA has determined provides adequate protection to the environment. The staff, therefore, concludes that impacts of the new nuclear unit on lake water quality would be SMALL, and mitigation would not be warranted.

5.4 Ecological Impacts

This section describes the potential impacts to ecological resources from operation of a new nuclear unit at the Exelon ESP site, transmission line operation, and transmission line right-of-way maintenance. The impacts are discussed for terrestrial ecosystems, aquatic ecosystems, and threatened and endangered species.

5.4.1 Terrestrial Impacts

Exelon has not determined the cooling tower configuration and design parameters for a new nuclear unit. This would have to be evaluated by the staff at the CP or COL stage. The new nuclear unit could use a wet, dry, or hybrid wet/dry system for plant cooling. For a wet system, mechanical or natural draft cooling towers would be employed, whereas a dry system would employ dry towers. Depending on the type of cooling towers that would be used to dissipate heat from the new nuclear unit, the rejected heat would be manifested in the form of vapor (wet system) and/or thermal (dry system) plumes from one or more locations within the cooling tower footprint. With vapor plumes, associated impacts due to salt drift, fogging, and icing would be possible. Because dry towers do not expose cooling water directly to the air, there would be no evaporative loss, and hence no vapor plumes, salt drift, fogging, or icing. Dry thermal plumes are not normally expected to result in significant environmental impacts (Exelon 2006a). For wet cooling processes, the resulting vapor plumes could impact crops and ornamental vegetation and native plants, and water losses could affect shoreline habitat. In addition, bird collisions and wildlife disturbance due to noise are possible with wet or dry cooling towers. Each of these topics is discussed below.

Transmission systems associated with nuclear power plants have the potential to impact terrestrial ecological resources through right-of-way management practices, bird collisions with power lines, and electromagnetic fields. Exelon currently anticipates that four new 345-kV transmission lines (two parallel, double-circuit lines running north to the Brokaw Substation near Bloomington and two running south-southwest to a point near the junction of the CPS-Oreana line and the Latham-Rising Line, about 19 km [12 mi] from the CPS switchyard) would be required to accommodate the bounding case of an output of 2180 MW(e) from a new nuclear unit (see Section 3.3) (Exelon 2006a). However, if a new unit is constructed, the actual need for and nature of any transmission system improvements would be determined definitively before or during the CP or COL stage by the transmission and distribution system owner and operator (currently Illinois Power) under FERC Order No. 2003 (18 CFR Part 35), *Standardization of Generator Interconnection Agreements and Procedures* (FERC 2004). The magnitude of the environmental impacts, given any transmission system improvements, would be established definitively by the transmission and distribution system owner and operator at that time. The impacts normally associated with transmission line operation and maintenance (right-of-way management [cutting and herbicide application] and associated impacts to floodplains and wetlands, bird collisions with power lines, and electromagnetic fields) are discussed below in light of any changes to the existing transmission system.

5.4.1.1 Cooling Tower Impacts

Impacts on crops, ornamental vegetation, and native plants might result from cooling tower salt drift, icing, fogging, or increased humidity. The heat dissipation system at the CPS is once-through. Because it has no cooling towers, there is no history of salt drift at the CPS that can be used to help evaluate this issue for a new nuclear unit. It is assumed that one or more new cooling towers at the ESP site would produce salt concentrations similar to those at other nuclear power plants that employ cooling towers. Impacts on crops, ornamental vegetation, and native plants have been evaluated at existing nuclear plants and found to be of small significance (NRC 1996). This determination included existing nuclear plants with various types and numbers of cooling towers. There are no important terrestrial plant species or habitats (defined in NRC 2000b) onsite, or in the immediate site vicinity, except for four minor (less than 0.4 ha [1 ac]) herbaceous wetlands that consist of open water in association with constructed sediment basins (Exelon 2006a). Consequently, based on previous staff evaluations (NRC 1996), a lack of important terrestrial plant species and habitats, and extensive agricultural land use onsite and in the immediate vicinity, the staff concludes that the potential impacts on crops, ornamental vegetation, and native plants from addition of one or more cooling towers for a new nuclear unit at the ESP site would be minimal and that mitigation would not be warranted.

Although the Exelon ESP site is located in central Illinois at a considerable distance from the Mississippi River, it lies in proximity to one of the principal routes of the Mississippi flyway. The CPS has a once-through cooling system. Because it has no cooling towers, there is no history of bird collisions at the CPS that can be used to help evaluate this issue for a new nuclear unit. However, the staff has concluded that bird collisions with cooling towers are of small significance at all operating nuclear power plants, including those with various types and numbers of cooling towers (NRC 1996). Consequently, the number of bird collisions, if any, associated with the addition of one or more cooling towers for a new nuclear unit at the ESP site would be negligible and mitigation would not be warranted.

5.4.1.2 Noise

For both natural and mechanical draft cooling towers, the noise level from cooling tower operation is anticipated to be 55 decibels at 300 m (1000 ft) (Exelon 2006a). Noise levels from dry cooling tower operation would be less than 65 decibels (Dominion 2002). Noise levels from these three types of cooling towers are well below the 80-to-85-decibel threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus, noise from operating any of these types of cooling towers would not be likely to disturb wildlife beyond the ESP site. Consequently, the potential impacts to wildlife posed by noise resulting from the addition of one or more cooling towers at the ESP site would be minimal and mitigation would not be warranted.

5.4.1.3 Shoreline Habitat

Addition of a new nuclear unit at the ESP site would reduce water volume in Clinton Lake, due to evaporative water loss from wet cooling tower operation. Additionally, by reducing the lake volume, a new unit would increase lake water temperature and evaporation above that caused by the discharge of once-through cooling water from the existing CPS. This would further reduce the lake volume. The reduction in water volume would decrease pool elevation and increase the amount and duration of lakebed exposed along the Clinton Lake shoreline. This would alter the amount and distribution of soil water which could alter the composition of shoreline vegetation. Existing vegetation could eventually be replaced with more drought hardy or exotic opportunistic species, which could affect wildlife use of shoreline habitat.

The staff analyzed the Clinton Lake water budget for the CPS and the CPS plus a new nuclear unit for a 51-year period between 1948 and 1999 (see Section 5.3). The estimated percentage of time minimum flows (0.14 m^3/sec [5 cfs]) would have to be released from the dam (i.e., water surface elevations below 210 m [690 ft]) increased from 43 percent (CPS only) to 68 percent (CPS plus new nuclear unit). The percentage of time with pool elevations below 207 m (680 ft) and 206 m (677.5 ft) would increase from 0 percent (CPS only) to 9 percent and 5 percent, respectively, if the CPS and new nuclear unit were operating. These represent substantial reductions in surface water elevation, and these would be expected to be greater in years with lower than normal precipitation.

Consequently, the additional water loss of a new nuclear unit's wet cooling tower(s) would result in longer, more extensive, and more frequent periods of lakebed exposure. However, because Clinton Lake bathymetry data are lacking, it is unknown where these drawdowns would expose the most lakebed along the lake perimeter. Without bathymetry data, it is also unknown how extensive the area of shoreline exposure would be. However, the upper arms of the lake, near the ingress of Salt Creek and North Fork Salt Creek, would probably be two of the areas most affected, because they are generally shallower than other parts of the lake. Lakebed exposure would likely be most severe during late summer and during drought years.

Based on the above water budget analysis, pool elevations estimated for the ESP unit plus CPS that would be below pool elevations estimated for the CPS only, could last up to about 1 month in late summer in any given year. Only minor long-term changes, if any, in shoreline vegetation and other wildlife use would be expected to result from exposed shoreline during such a relatively brief period, regardless of where along the shoreline the lakebed was exposed or the aerial extent of the exposure. For example, drawdowns would be expected to minimally affect, if at all, the reproduction of birds that nest in emergent vegetation (e.g., pied-billed grebe [*Podilymbus podiceps*] [see Section 2.7.1.1]) via stranding of nests and increased predator access, because young would already have been reared by that time of year. Consequently, changes in shoreline vegetation and wildlife use due to the addition of a new nuclear unit would be negligible and mitigation would not be warranted.

5.4.1.4 Transmission Line Rights-of-Way

Routine inspections of the existing transmission line rights-of-way for vegetation control are conducted by helicopter three times per year. Routine vegetation control, which consists of clearing vegetation that encroaches on the line exclusion area, is performed every 4 years unless required sooner. No vegetation over 3 m (10 ft) tall is allowed within the transmission line exclusion area. Tree species with the potential for resprouting may be controlled with an environmentally acceptable selective basal spray herbicide. The same vegetation management practices currently in effect for the rights-of-way would be applied to any rights-of-way for a new nuclear unit. Transmission line right-of-way maintenance activities have been evaluated and the impacts were found to be of small significance at operating nuclear power plants, including those with variable numbers of rights-of-way of variable widths (NRC 1996). Consequently, the incremental impacts of right-of-way management for any transmission system upgrades (see Section 4.4.1.1) for a new nuclear unit would be minimal and mitigation would not be warranted.

There are no known reports by transmission-line-operation and right-of-way maintenance personnel of dead birds resulting from collisions with the existing transmission system structures. However, there is currently no monitoring plan in place that would facilitate detection and reporting of dead birds under transmission lines. Bird collisions with transmission lines have been determined to be of small significance at operating nuclear power plants, including those with variable numbers of rights-of-way and power lines (NRC 1996).

Thus, although upgrading of the existing transmission system could be required for a new nuclear unit at the Exelon ESP site, this would likely present few new opportunities for bird collisions beyond those currently in existence. Further, the additional number of bird collisions, if any, would not be expected to cause a noticeable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by possible transmission-system upgrades for a new nuclear unit at the ESP site would be negligible and mitigation would not be warranted.

5.4.1.5 Impacts of Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock)

As discussed in the GEIS for License Renewal (NRC 1996), a careful review of the biological and physical studies of electromagnetic fields (EMFs) has not revealed consistent evidence linking harmful effects with field exposures. Since 1997, over a dozen studies have been published that looked at cancer in animals that were exposed to power-frequency electromagnetic fields for all of, or most of, their lives. These studies have found no evidence that power-frequency fields cause any specific types of cancer in rats or mice (Moulder 2004). EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and long-term effects, if real, are subtle. Therefore, the staff concludes that the impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including those with variable numbers of transmission lines (NRC 1996). Consequently, the incremental EMF impacts posed by possible addition of new transmission lines for a new nuclear unit at the ESP site would be minimal and mitigation would not be warranted.

5.4.1.6 Floodplains and Wetlands on Transmission Line Rights-of-Way

The same vegetation management practices currently in effect for the existing rights-of-way (see Section 5.4.1.4) would be applied to any expanded or new rights-of-way that might result from transmission system upgrades for a new nuclear unit. Vegetation management could thus occur over a larger floodplain/wetland interface. The effects of transmission line right-of-way maintenance activities on floodplains and wetlands have been evaluated and the impacts were found to be of small significance at operating nuclear power plants, including those with variable numbers of transmission line rights-of-way of variable widths (NRC 1996). Consequently, the incremental effects of transmission line right-of-way management on floodplains and wetlands posed by any transmission system upgrades for the new nuclear unit would be negligible and mitigation would not be warranted.

5.4.1.7 Summary of Terrestrial Ecosystems Impacts

The potential impacts of operating one or more cooling towers on the Exelon ESP site for a new nuclear unit are considered negligible for crops, ornamental vegetation, native plants, bird collisions, wildlife due to noise, and vegetation and wildlife due to alteration of shoreline habitat. The potential impacts of transmission line right-of-way management activities (cutting and herbicide application), related impacts on floodplains and wetlands in transmission line rights-of-way, impacts on wildlife due to EMF, and on bird collisions with power lines resulting from any transmission system upgrades are also considered negligible.

After reviewing information related to the proposed new nuclear unit for the ESP site, including the associated heat dissipation system, transmission system structures, and associated right-of-way maintenance, the staff concludes that the impacts from operation of a new nuclear unit would be SMALL and that mitigation would not be warranted.

5.4.2 Aquatic Impacts

Section 2.7.2 contains a discussion of the aquatic ecology of the Exelon ESP site. Impacts of a new nuclear unit on aquatic organisms in Clinton Lake and/or Salt Creek may arise through water intake, consumption, and discharge. The location, design, and operation of a new intake structure would be regulated by the IEPA to minimize impingement and entrainment of aquatic organisms. The IEPA also regulates thermal limits for heated water discharges, which can affect organisms indirectly by impacting water quality, such as dissolved oxygen, and directly when water is heated or cooled to a temperature outside an organism's acclimation tolerance range. Exelon plans to maintain the cooling water discharge from a new nuclear unit within the existing NPDES limits for the CPS. Exelon's and the staff's independent assessment of the potential for impacts to the local aquatic ecology from operation are discussed in Sections 5.4.2.1 and 5.4.2.2, and then summarized in Section 5.4.2.3.

5.4.2.1 Water Intake and Consumption

For aquatic resources, the primary concerns of water intake and consumption are the amount of water drawn from the cooling water source (i.e., Clinton Lake), the design and location of the cooling water intake structure, and the potential for organisms to be impinged on the intake screens or entrained into the cooling-water system. Impingement takes place when organisms are trapped against intake screens by the force of the water passing through the cooling-water intake structure. Impingement can result in starvation and exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged periods of time), and descaling and other mechanical damage. Entrainment occurs when organisms are drawn through the cooling water intake structure into the cooling system. Organisms that become entrained are normally relatively small benthic, planktonic, and nektonic organisms, including early life stages of fish and shellfish, and often serve as food for larger organisms. As entrained organisms pass through a plant's cooling system, they are subject to mechanical, thermal, and/or toxic stress.

The U.S. Environmental Protection Agency (EPA) has promulgated regulations that implement Section 316(b) of the Federal Water Pollution Control Act of 1972 for new and existing electric power producing facilities (66 FR 65255; 69 FR 41576). The regulations apply to facilities that employ a cooling water intake structure and are designated to withdraw 50 million gallons per day or more of water from waters of the United States for cooling purposes. The new nuclear unit would be subject to these regulations. The regulations establish performance standards that are designed to reduce impingement mortality by 80 to 95 percent and entrainment by 60 to 90 percent. The new regulations state that if the facility employs a closed-cycle cooling system, the facility is deemed to have met the performance standards to reduce impingement mortality and entrainment. Exelon has not yet finalized a detailed design of the cooling water system. However, the applicant proposes a PPE that includes a cooling system that employs mechanical draft, natural draft, or a wet/dry hybrid cooling systems, all of which are considered closed-cycle cooling systems.

The responsibility for making the determination that the cooling water intake structure reflects the best available technology for minimizing adverse impacts rests with the EPA or its designee, i.e., IEPA, which would make decisions implementing Section 316(b) on a case-by-case, site-specific basis. Exelon would work with the IEPA to design the intake system to comply with the EPA regulations for new intake structures.

The specific components and design of the cooling water system at a new nuclear unit would not be determined before the COL phase. However, Exelon's ER (Exelon 2006a) provides general descriptions of a nuclear unit's cooling system operational modes, component descriptions, normal heat sink and ultimate heat sink, and cooling system instrumentation.

The primary water demand for a new nuclear unit would be for condenser cooling. In its ER, Exelon discusses using either a wet tower closed-loop cooling system or a hybrid wet/dry closed-loop cooling system. The PPE provides bounds for a wet tower cooling system but no similar values for the hybrid wet/dry cooling system. The staff has assumed that water used for the hybrid wet/dry cooling system is bounded by the wet cooling system values. Therefore, the following discussion is limited to the wet tower system. The hybrid wet/dry cooling system will not be addressed further in this section.

Based on the expected intake velocity and flow rate, the new intake structure would be approximately 34 m x 46 m (110 ft x 150 ft) in shore-to-lake dimensions. Preliminary plans call for water drawn from Clinton Lake to pass through bar racks or a similar device that are designed to keep large debris (e.g., tree branches) from entering the cooling water system. The water would then pass through traveling screens that allow water to pass but remove small debris (e.g., leaves) by the rotation of the screens and with the help of a water spray. The debris removed from the screens would be held in trash collection baskets so it could be inspected before disposal. The velocity of the water approaching the traveling screens would be limited to a maximum of 0.15 m/s (0.50 fps) at the normal lake-level elevation of 210 m (690 ft) above mean sea level (Exelon 2006a).

Exelon has stated that it plans to maintain a discharge rate within the current NPDES permit limits for the CPS. The current CPS relies on once-through cooling. The expectation of the original environmental assessment for the CPS was that Clinton Lake would be able to support two once-through cooling units. In its ER, however, Exelon proposed a closed-cycle cooling tower for a new nuclear unit, which requires less water to be drawn from Clinton Lake than does a once-through cooling system.

The relatively low overall water use estimated for the closed-cycle cooling water intake for a new nuclear unit would minimize impingement and entrainment, and compliance with the EPA regulations for new intake structures would ensure that aquatic organisms are protected. Nationwide experience with similar operating cooling-tower-based systems has indicated that "the relatively small volumes of makeup and blowdown water needed for closed-cycle cooling systems result in concomitantly low entrainment, impingement, and discharge effects" (NRC 1996).

The adjacent CPS intake structure would be considered an "existing" structure under a separate EPA ruling for existing facilities and would also be required to meet performance standards that protect aquatic organisms based on the facility's source water (e.g., lake or reservoir). On July 9, 2004, the EPA published a final rule in the *Federal Register* (69 FR 41576) addressing cooling water intake structures at existing power plants whose flow levels exceed a minimum threshold value of 190,000 m^3/d (50 mgd). The rule is Phase II in EPA's development of regulations under Section 316(b) of the Federal Water Pollution Control Act of 1972 (also referred to as the Clean Water Act) and establishes national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceed the threshold value for water withdrawals. The national requirements, implemented through NPDES (or equivalent State) permits, minimize the adverse environmental impacts associated with the continued use of the intake systems. Licensees are required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES (or equivalent State) permit. Licensees may be required as part of the permit renewal to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigation measures as a result of this regulation. The new performance standards are designed to significantly reduce impingement and entrainment losses due to water withdrawals associated with cooling water intake structures used for power production. Therefore, impingement and entrainment losses as a result of continued operation of the CPS will continue to be minimized under the EPA regulations.

Information on recent entrainment studies, if any, was not available for the CPS. A discussion of entrainment in the CPS Final Environmental Statement (AEC 1974) indicated that the recreational fish species in Clinton Lake (e.g., sunfish, bass, crappie, walleye, and catfish) are nest builders, and that the eggs and small juveniles are closely associated with nest sites located in the shallow, littoral zones of the lake or in the two creeks that feed the lake (Lutterbie 2002). The intakes for the CPS and a new nuclear unit are located in a relatively deep portion of this shallow lake (at approximately 6.4 m [21 ft] depth), where these species are less likely to spawn. Combined with the EPA requirements to meet best available technology for new and existing cooling water intake structures and the fish-stocking programs managed by the Illinois Department of Natural Resources (IDNR), the location of the intakes decreases the likelihood of significant entrainment impacts to important aquatic species from the operation of an intake for a new unit, either on its own or in combination with the CPS cooling water intake.

A fish-impingement study was conducted during the first year of CPS operation, from April 1987 to May 1988 (Pallo 1988). Eight fish species were collected during 84 sampling days. Gizzard shad (*Dorosoma cepedianum*) composed over 99 percent of the total estimated count and the biomass of impingement collections. Other species observed in descending order of estimated annual abundance were white crappie (*Pomoxis annularis*, n = 2338), freshwater drum (*Aplodinotus grunniens*, n = 758), black bullhead (*Ameiurus melas*, n = 148), bluegill (*Lepomis macrochirus*, n = 82), hybrid striped bass (*Morone saxatilis X M. chrysops*, n = 26), channel catfish (*Ictalurus punctatus*, n = 17), and largemouth bass (*Micropterus salmoides*, n = 16). It was estimated that over 43-million gizzard shad, mostly young-of-the-year, were impinged during the study. This number, though high, must be taken in context of the gizzard shad's fecundity. Females may contain between 22,400 and 543,000 eggs each (Jenkins and Burkhead 1993). This prolific forage fish species typically experiences a naturally high young-of-the-year mortality rate and commonly demonstrates mass mortality in winter when water temperatures approach 4°C (39.2°F). Most of the fish were collected in winter (December through March) when water temperatures declined and then held steady between 4° to 6°C (39.2° to 42.8°F) (Pallo 1988). Fortunately, the species has the ability to compensate for high juvenile mortality by producing a large amount of young. Abundance of gizzard shad has been high since operation of the CPS began, indicating that there are no apparent adverse impacts to the population as a result of current cooling water intake withdrawals. In fact, gizzard shad in Clinton Lake are smaller on average than gizzard shad in many other Illinois lakes, possibly indicating that overabundance of the fish is creating strong competition among shad for food and other resources.[(a)] The almost exclusive impingement of the abundant gizzard shad, combined with the EPA requirements to meet best available technology for new and existing cooling water intake structures and the recreational fish-stocking programs managed by IDNR, decreases the likelihood of significant impingement impacts to important fish species from the

(a) Personal communication on March 2, 2004, with Mike Garthaus (Illinois Department of National Resources).

operation of an intake for a new nuclear unit, either on its own or in combination with the CPS cooling water intake operation. However, a full review of anticipated impacts to important fish resources due to impingement cannot be performed without a specific cooling water intake design. The new intake structure would be located on the North Fork of Salt Creek, along with the existing CPS intake structure. Because of the relatively small volume of water in the North Fork, there is a potential for localized cropping of some species when the CPS and the ESP unit are both operational, affecting impingement or entrainment rates.

There would be a reduced volume of water in Clinton Lake, due to increased evaporative water loss associated with the cooling towers of a new nuclear unit. This would result in shorter times for the water to recirculate from the discharge back to the intake (see also Section 5.3.1). This reduction in travel time would increase average temperature in the lake, thereby contributing to additional induced evaporation in the lake. The reduced volume of water in Clinton Lake would decrease the pool elevations and would increase the amount of shoreline exposed. The increased water use and evaporative loss from operation of a new nuclear unit at the ESP site could also increase the amount of time additional shoreline is exposed. Depending on the season and the duration and amount of shoreline exposure, it is possible that shoreline vegetation and aquatic organisms could be affected. However, because the mechanism for drawdown would be evaporation and/or discharge of 0.14 m^3/s (5 cfs) to Salt Creek, the drawdown would likely be slow enough to allow most aquatic organisms to adjust to the lower water levels. In severe cases, it is possible that some shallow-water fish spawning areas could be exposed, but this is unlikely to have a lasting impact on the Clinton Lake fish community structure. Other potential impacts associated with an increase in average lake temperature are a decrease in the amount of cool-water summer refugia for fish and an alteration in the timing of fish spawning events. These issues would be evaluated in detail at the CP or COL stage.

5.4.2.2 Water Discharge

For aquatic resources, the primary concerns related to water discharge are the effects of heated effluents on fish and other aquatic organisms (NRC 1996). Heated effluent temperatures may be high enough to kill some organisms, especially in the area nearest the effluent discharge structure. The amount of suitable habitat available to important aquatic species (i.e., within the species' tolerance range of temperature and dissolved oxygen) may be reduced during warm summer months. In addition to heat effects, there may be impacts to important aquatic species if they are exposed to a sudden decrease in temperature when artificial heating ceases. For example, the condition known as cold shock may occur if power plants are shut down suddenly in winter (NRC 1996).

The NPDES permit program, authorized by the Clean Water Act (CWA), controls water pollution, including heated effluents, by regulating point sources that discharge pollutants into waters of the United States. The CPS currently discharges waste water to Clinton Lake under

NPDES permit IL0036919 issued by the IEPA (IEPA 2000). Future waste water discharges from the new nuclear unit would be in compliance with a similar approved NPDES permit with discharge limits established by the IEPA. The IEPA is required to take into consideration the cumulative impacts of multiple discharges to the same waterbody, and discharges from the CPS and other area facilities would be included in the review and development of permit requirements for any new nuclear unit. Additionally, all NPDES permits must be renewed every 5 years, allowing IEPA to ensure that the permits provide the appropriate level of protection to the environment.

A new nuclear unit, under all of the cooling alternatives, would add its discharge to the existing CPS discharge flume. The only modification would require making a new unit's discharge pipe connect to the portion of the existing flume that was originally provided for the circulating water discharge of the CPS Unit 2, which was never constructed (Exelon 2006a). Exelon has expressed a goal of maintaining the combined CPS and new unit discharge flows and temperatures within the conditions of the current NPDES permit for the CPS (Exelon 2006a; IEPA 2000).

If a new nuclear unit were to operate alone (no concurrent discharge from the CPS), lake temperature increases would likely be proportional to the increase in flow and temperature that has been observed for the CPS facility.

The average lake temperature, determined by monitoring during the CPS pre-operational period (1985 and 1986), was 13.3°C (55.9°F) (IPC 1992). The average lake temperature monitored over 5 years after CPS operation (1987 through 1991) was 21.1°C (70.0°F) (IPC 1992). Based on these data, the CPS unit has increased lake temperatures approximately 7.8°C (14°F) over the pre-operational conditions, although temperatures were not collected during some operational period winter months which may bias this comparison (IPC 1992). Temperature differences between pre-operational and CPS operational periods were most noticeable at the discharge sampling station and at the 1- and 2-m (3- and 7-ft) depth strata (IPC 1992). Water temperature increases would be most critical near the discharge and during the summer months, when recirculating water volumes, ambient air temperatures, and water temperatures are high. Exelon states in its ER that "if a cooling method is selected that has a consumption rate that exceeds the available water for drought conditions, it may be necessary for periods of time to reduce or curtail plant operation to protect the minimum lake level and integrity of the ultimate heat sink" (Exelon 2006a). This may also be necessary to keep temperatures below the limits allowed by the NPDES permit at the discharge and by the Illinois Pollution Control Board at the Salt Creek monitoring station, 30.5 m (100 ft) downstream of the Clinton Lake Dam.

Water temperature is an important factor in the maintenance of a healthy aquatic environment. Temperature regulates the metabolism and composition of aquatic communities. Elevated temperatures increase metabolism, respiration, and oxygen demand for aquatic organisms

(IPC 1992). During warm weather, an upper, heated layer of water may form at the lake surface. In most lakes, this is a result of the absorption of solar energy. In Clinton Lake, this thermal stratification is caused by the combination of solar energy and the discharge of heat from the CPS. The heated upper layer floats over a cooler, deeper, more dense layer of water. During sustained thermal stratification, mixing between layers is inhibited and the deep waters may not have any direct contact with the atmosphere. As biota living in the deep waters respire, the amount of oxygen is depleted. As a result, there may be periods when only the upper layers are able to support a diversity of aerobic aquatic life. Between 1978 and 1991, the Illinois Power Company (IPC) monitored temperature in Clinton Lake at five sites. Stratification occurred each year, but not at every site sampled. In general, the deeper sites were more likely to exhibit complete stratification, and stratification was most likely to occur between May and September (IPC 1992).

IPC analyzed the potential impacts of high lake temperatures on fish in the lake before CPS operation (IPCB 1993). The thermal tolerance limits of six fish species were compared to the 43.7°C (110.7°F) maximum and the 37.2°C (99°F) 90-day limit allowed under the NPDES permit. The six species were gizzard shad, common carp, channel catfish, bluegill, largemouth bass, and white crappie. An EPA protocol was used to assess impacts on reproduction, growth, and survival for each species, using preferred thermal limits and habitats for each species drawn from the existing literature. Minimal impacts were predicted for the reproduction, growth, and survival of gizzard shad, common carp, and bluegill. Minimal impacts were likewise predicted for the survival and growth of channel catfish and largemouth bass, but reproduction in these species was predicted to be limited during the spawning season. Substantial impacts were predicted for white crappie. Under severe ambient summer conditions, the species was not predicted to survive. Since operation of the CPS began, the white crappie population has indeed experienced a decline. However, the black crappie population has increased proportionally over the same time period and now comprises greater than 80 percent of the crappie population in the lake (Lutterbie 2002).[a] The IDNR does manage and stock a number of recreational sport fish species in the lake annually, including hybrid striped bass, striped bass, smallmouth bass, walleye, and white crappie (IDNR 2004a). The stocking program ensures that the number and variety of recreational species is maintained from year to year.

Dissolved oxygen (DO) levels are also important to the protection and maintenance of a well-balanced aquatic community. Concentrations of DO vary inversely with temperature and may vary widely between day and night as plants photosynthesize (DO increases) and respire (DO decreases). There has been a significant decrease in the average DO concentration in Clinton Lake since operation began, from 10.2 mg/L to 7.8 mg/L (IPC 1992). In general, a DO concentration of 5 mg/L is sufficient to support a healthy aquatic community (EPA 1986).

(a) Personal communication on March 2, 2004, with Mike Garthaus (Illinois Department of Natural Resources).

During the CPS operational period, 4 percent of the DO samples monitored were below 5 mg/L, compared to less than 1 percent during the pre-operational period. The DO reached its lowest levels during August and September and generally decreased with increasing water depth. However, the majority of the lake had DO levels above 5 mg/L at any given time (IPC 1992).

It is not uncommon for lakes in Illinois to have depleted DO in bottom waters during the summer. Fish generally avoid areas that exhibit a water temperature or DO concentration outside their preferred range by swimming to another region of the lake. However, there has been at least one occasion when striped bass inhabiting cooler waters in the deep portions of the lake (e.g., submerged gravel pits located near the Clinton Lake Marina) have died as a result of low oxygen levels associated with thermal stratification during the summer.[a] These instances are rare, however, and under current CPS operating conditions, the balance of indigenous and stocked recreational fish populations in the lake is being maintained.[a] The small increase in average lake temperature during combined operations of the CPS and a new nuclear unit, so long as it remains within the NPDES limits currently in place, are not expected to adversely affect important aquatic organisms or upset the balance of the aquatic community in Clinton Lake or its tributaries (i.e., Salt Creek and the North Fork of Salt Creek).

The effects of heated discharges on other organisms is generally limited to localized areas, usually in the vicinity of the discharge. In this area, localized reductions in coldwater species or increases in warmwater species are possible, but the effects are limited to small areas and have not been found to alter large geographic distributions (NRC 1996). Because the heated effluent discharge of a new nuclear unit would be combined with that from the CPS, the localized area impacted would likely increase somewhat as increased water temperatures advanced farther from the discharge toward the intake.

Impacts to Salt Creek, downstream from the Clinton Dam, have also been considered under the current permitted NPDES limits. It is expected that water temperatures immediately downstream of the Clinton Dam would increase slightly with the addition of heated effluent discharge from a new nuclear unit to that of the CPS (Exelon 2006a). Summer stream temperatures currently range between 1.1° and 4.4°C (2° and 8°F) higher than those at the Rowell gauging station located 19.3 km (12 mi) downstream of the Clinton Dam (Exelon 2006a). However, the influence of the additional heated effluent would likely diminish over distance and be undetectable at the Rowell gauging station (Exelon 2006a). Temperature data collected from pre-dam to post-CPS operation indicate that Salt Creek temperatures at Rowell have not been influenced by increased temperatures in Clinton Lake (Exelon 2006a). Based on CPS post-operational monitoring data, the Illinois Pollution Control Board found in 1993 that no abnormal temperature changes have occurred in Salt Creek below the dam, that

(a) Personal communication on March 2, 2004, with Mike Garthaus (Illinois Department of Natural Resources).

normal seasonal fluctuations are maintained in the creek, and that water temperatures in Salt Creek have not exceeded 2.8°C (5°F) above background temperature for more than 1 percent of the time in a given calendar year. Therefore, it is expected that impacts resulting from discharge of heated effluent on the distribution of aquatic organisms would be minimal.

Another factor related to thermal discharges that may affect aquatic biota is cold shock. Loss of heat input to the discharge flume during cold winter months results in a large drop in lake temperature in the vicinity of the discharge flume. Many fish species congregate in the warm lake waters surrounding the discharge during winter, as fishermen can attest. Nuclear plants must cease operation to refuel on a periodic basis. This is often planned for winter time when demand for electricity is relatively low. A planned station shutdown is generally conducted over a lengthy period of time so that heated discharge is gradually reduced and fish have time to acclimate to the change in water temperature. If water temperature drops too rapidly, fish may be overly stressed and die. Whenever possible, the removal of heat from the discharge stream should be very gradual, especially in winter. It is generally accepted that a 2°C per hour (3.6°F per hour) change in temperature is adequate for most fish species and individuals to acclimate without adverse effect (Oliver and Fidler 2001).

Two fish-kill events caused by cold shock have been recorded for the CPS in winter since operation began, the first in January 2001 and the second in February 2004 (Petro 2001; Bement 2004). While there are no requirements to monitor Clinton Lake for fish kills, there are procedures set forth in the CPS Environmental Protection Plan that dictate when the NRC and other agencies must be notified in the event of an unusual or important environmental event, such as a fish kill. Upon discovery, the NRC must be notified within 24 hours, along with other agencies with responsibility for protecting the aquatic environment (i.e., IDNR and IEPA). IDNR, in accordance with the CPS Lake Management Agreement, has the responsibility to patrol the lake and conduct initial assessments of any fish kills (Petro 2001). A followup report must be submitted to the NRC within 30 days of the occurrence of a nonroutine event that (a) describes, analyzes, and evaluates the event, including the extent and magnitude of the impact and plant operating characteristics, (b) describes the probable cause of the event, (c) indicates the action taken to correct the reported event, (d) indicates the corrective action taken to preclude repetition of the event and to prevent similar occurrences involving similar components or systems, and (e) indicates the agencies notified and their preliminary responses (IPC 1987). A similar Environmental Protection Plan and requirements for the disclosure, investigation, and analysis of nonroutine environmental impacts would be expected to be part of an operating license for a new nuclear unit at the Exelon ESP site. This could be included as part of a COL.

In the 2001 and 2004 events, the IDNR investigated the fish kill and performed shoreline surveys to identify and quantify the numbers of fish killed. The majority of fish observed are not usually considered sport fish: bigmouth buffalo (*Ictiobus cyprinellus*), gizzard shad, freshwater drum, quillback (*Carpoides cyprinus*), and carp (*Cyprinus carpio*). The loss of these fish was localized and likely to be temporary in nature (Petro 2001; Bement 2004). Some of the sport fish that were lost in the event are stocked annually by IDNR to provide recreational fishing opportunities for anglers. As these sport fish will be replaced during future stocking events, the overall abundance will not be reduced.

Overall, the number of fish lost was considered small in relation to the total abundance of these fish species throughout Clinton Lake and throughout the surrounding region (Petro 2001; Bement 2004). Their loss did not have any long-term adverse effect on the future fish population structure. A species-specific evaluation of the number of fish lost compared to the number of fish estimated to inhabit Clinton Lake (carrying capacity) would provide a more accurate assessment of the relative impact of these losses to the Clinton Lake fish population; however, these data are unavailable.

The possibility of a cold shock event is less likely when two sources are producing heated effluent and discharging it to the lake at the same location because it is unlikely that both plants would be shut down simultaneously. However, some cold shock could still occur with sudden shutdown of the CPS, because blowdown from a closed-cycle new nuclear unit would not produce as much heated effluent as the CPS.

One of the plant operational activities that would require consideration under the NPDES permit is chemical treatment of the cooling water and of the water processed through the reactor-coolant cleanup system. This might entail the periodic use of scale inhibitors, corrosion inhibitors (chloride), and sulfuric acid for pH adjustment (Exelon 2006a). Biological inhibitors such as biocides, dispersants, and molluscicides might also be required on a periodic basis to reduce biofouling of the cooling towers and the shell side of the primary heat exchangers (Exelon 2006a). If a wet cooling system were selected for a new nuclear unit, it might also be necessary to incorporate a de-icing compound in the cooling water during colder months (Exelon 2006a). If proven necessary, potable water used throughout the plant might be treated with an antibacterial inhibitor such as chlorine and monitored on a monthly basis (Exelon 2006a). It is expected that the discharge limits set forth by IEPA for these chemical additives would be sufficient to protect aquatic biota.

5.4.2.3 Summary of Aquatic Impacts

Given the information provided in the applicant's ER and the staff's independent review, impacts on aquatic ecosystems from operation of the intake system would likely be SMALL during normal water years, provided the velocity through the screens is less than 0.5 ft/sec and the applicant uses a closed cycle or a hybrid cooling system. The intake structure design and permit requirements that would be set by the IEPA are unknown at this time. The cooling water intake system impacts could be MODERATE if best available technology is not utilized at the

CPS and localized reduction or “cropping” of fish occurs beyond what natural spawning or “recruitment” can replace, as a result of joint operation of the CPS and ESP unit.

The staff also concludes that during normal water years, operational impacts of the plant cooling water system other than impingement and entrainment would be SMALL. During low water years, however, the impact to the water level, and thus to the water temperature and available habitat, could be MODERATE until normal water conditions and lake level return. In such cases, the applicant would need to coordinate with IEPA on appropriate measures, including derating or even temporary unit shutdown.

An applicant for a CP or COL referencing any ESP that may be issued for the Exelon ESP site would need to provide additional information on the intake structure design and expected NPDES permit requirements regarding impingement, entrainment, and thermal effects on aquatic organisms in order for the staff to make a significance determination with respect to this resource.

Based on its review, the staff concludes that additional information on the intake structure design and NPDES permit requirements for the ESP unit is needed in order to determine the impacts to aquatic ecology due to the operation of one or more nuclear units at the Exelon ESP site. Therefore, the staff concludes that the aquatic ecology issues associated with operation of a proposed ESP unit are unresolved.

5.4.3 Threatened or Endangered Species

This section describes the potential impacts to Federally listed or proposed threatened or endangered species and associated designated and proposed critical habitat from operation of a new nuclear unit on the Exelon ESP site, transmission lines, and maintenance of associated rights-of-ways. The biology of these species is presented in Sections 2.7.1 and 2.7.2.

The staff prepared a biological assessment documenting the impacts of operation of a new nuclear unit on the Federally listed threatened and endangered terrestrial species described in the U.S. Fish and Wildlife Service (FWS) correspondence (FWS 2004). The staff’s impact determinations from the biological assessment are reiterated in this section.

There are two Federally listed species, the threatened bald eagle (*Haliaeetus leucocephalus*) and the endangered Indiana bat (*Myotis sodalis*), that may occur in the vicinity of the ESP site and existing transmission corridors (FWS 2004).

Bald Eagle - Threatened

Bald eagles are not known to nest but are known to winter along large rivers, lakes, and reservoirs in DeWitt County and have been observed in the vicinity of the Exelon ESP site (Exelon 2006a). However, there are no known night roost sites in DeWitt County (FWS 2004). Further, no concentrations of foraging eagles have been reported on or in the vicinity of the ESP site (Exelon 2006a; FWS 2004; IDNR 2004b). No critical habitat is designated for the bald eagle (FWS 2004).

Bald eagles may be affected by an operating nuclear unit via collisions with cooling towers and transmission lines. Generic impacts of cooling towers on bird collisions were evaluated in Section 5.4.1 and were found to be minimal. The bald eagle is an infrequent visitor to the project area and typically roosts at night when visibility is poorest and the possibility for collisions with cooling towers is greatest. This further minimizes the potential for bald eagle collisions with cooling towers.

Generic impacts of transmission lines on bird collisions were also evaluated in Section 5.4.1 and were found to be minimal. Again, because the bald eagle is an infrequent visitor to the project area, the potential for collisions with transmission lines is further minimized.

Indiana Bat - Endangered

Because the Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004), it could occur in forested areas on and in the vicinity of the Exelon ESP site and along the transmission line rights-of-way, although there are no records of its occurrence within 16 km (10 mi) (IDNR 2004b). If present, Indiana bats would most likely occur in association with small streams with well-developed riparian woods, as well as with mature floodplain and upland forests. It roosts and rears its young beneath the loose bark of large dead or dying trees, and tends to return to the same roosting area year after year (FWS 2004). Indiana bats winter in caves and abandoned mines (FWS 2004).

To be impacted by operation of a new nuclear unit, suitable Indiana bat summer habitat would have to occur within a transmission line right-of-way, where bats could be affected by right-of-way management (i.e., cutting and herbicide application) and EMFs. It is very unlikely that suitable summer habitat would occur in a transmission line right-of-way, because right-of-way maintenance practices preclude vegetation over 3 m (10 ft) tall (see Section 5.4.1.4) and thus preclude riparian woods, mature floodplain and upland forests, and large trees. Further, generic impacts of right-of-way management and EMFs were evaluated in Section 5.4.1 and were found to be minimal. Consequently, impacts from operation of a new nuclear unit on Indiana bats are expected to be negligible.

Station Operation Impacts

The only critical habitat designated for the Indiana bat is the Blackball Mine in LaSalle County, Illinois (41 FR 41914). Consequently, there would be no operational impacts to Indiana bat critical habitat because none occurs in the vicinity of the Exelon ESP site.

Federally Listed or Proposed Aquatic Animals

No impacts to Federally listed or proposed threatened or endangered aquatic animal species or associated proposed or designated critical habitat are anticipated, because none is known to occur on or within 16 km (10 mi) of the Exelon ESP site (Exelon 2006a; FWS 2004; IDNR 1999) or in the vicinity of the transmission line corridor (FWS 2004).

Federally Listed or Proposed Terrestrial and Aquatic Plants

No impacts to Federally listed or proposed threatened or endangered terrestrial or aquatic plant species are anticipated, because none is known to occur on or within 16 km (10 mi) of the Exelon ESP site (IDNR 2004b; FWS 2004) or in the vicinity of the transmission line corridor (FWS 2004).

Conclusions

In summary, there would be no operational impacts to Federally listed or proposed terrestrial or aquatic plant species and no operational impacts to Federally listed or proposed aquatic animal species. Operational impacts to Federally listed terrestrial animal species, the bald eagle and Indiana bat, are expected to be negligible. There would also be no operational impacts to designated or proposed critical habitat for Federally listed or proposed terrestrial or aquatic animal species. Exelon has committed to contact the FWS before beginning operation to ascertain whether these assumptions remain valid or whether further evaluation is needed.

Based on its review of a new nuclear unit at the Exelon ESP site and associated heat dissipation and transmission systems, the staff concludes that the impacts of operation on Federally listed or proposed threatened or endangered aquatic or terrestrial species would be SMALL, and mitigation would not be warranted. The conclusion of SMALL impacts by the NRC staff is predicated on certain assumptions made by the staff. These include the current occurrence of Federally listed threatened and endangered species and critical habitat in the project area, the current listing status of such species, and the current designation of critical habitat.

5.5 Socioeconomic Impacts

This section describes the socioeconomic impacts of operating a new nuclear unit at the Exelon ESP site and of the activities and demands of the operating workforce on the surrounding region. Socioeconomic impacts include potential impacts on individual communities, the surrounding region, and minority and low-income populations.

5.5.1 Physical Impacts

This section assesses the potential physical impacts on the nearby communities caused by operation of a new nuclear unit at the Exelon ESP site, including noise, odors, exhausts, thermal emissions, and visual intrusions. As stated in its ER, Exelon plans to manage these physical impacts to comply with applicable Federal, State, and local environmental regulations and, therefore, operation of a new nuclear unit would not significantly affect the ESP site and the vicinity (Exelon 2006a). The staff's evaluations are discussed in the following sections.

5.5.1.1 Workers and the Local Public

A new nuclear unit at the Exelon ESP site would be co-located and operated on the site of the CPS, 210 m (700 ft) south of the CPS and adjacent to the CPS's 1981-ha (4895-ac) cooling reservoir, Clinton Lake. Except for the structures at the CPS, there are no industrial, commercial, or institutional structures on the site. Industrial is the only type of land use on the site (Exelon 2006a). Main access to the Exelon ESP site is provided by Illinois State Route 54.

The terrain around and on the plant site is undulating and wooded. The region surrounding Clinton Lake and the Exelon ESP site is farmland, interspersed with occasional forest and brushwood. Most of the existing CPS site structures are screened from public view, except for visitors near Weldon off State Route 10 and near the visitors center off State Route 54. It is expected that a new nuclear unit would have similar visual limitations.

There are no residential areas located within the Exelon ESP site boundary. The nearest residence to the site is (1.2 km) (0.73 mi) away. The nearest towns are DeWitt (population 188) and Weldon (population 440) (USCB 2000a). The City of Clinton is 10 km (6 mi) west of the site. The population in the vicinity of the Exelon ESP site is about 2940 (Exelon 2006a).

The existing CPS produces noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment. It is expected that this would continue with the installation of a new nuclear unit at the ESP site. Most equipment would be located inside structures that would tend to reduce the outdoor noise level. Building walls would reduce outside noise levels as much as 15 decibels. Further reduction would be achieved as the noise travels to the site's property line (Exelon 2006a).

Station Operation Impacts

The many pieces of large industrial equipment needed for operations at a nuclear unit (freight trucks, forklifts, etc.) would also be a source of noise and air pollution. It is expected that standard noise suppression devices on trucks and other equipment would be sufficient to keep offsite noise levels well within acceptable levels. In addition, activities requiring the use of heavy equipment would be limited on weekends. Finally, Exelon states it would adhere to applicable air pollution regulations as they relate to the operation of fuel-burning equipment (Exelon 2006a).

Exelon is evaluating several cooling options, including a proposed wet cooling system that would utilize mechanical or natural draft cooling towers. Natural and mechanical draft cooling towers emit broadband noise; therefore, the noise associated with the cooling towers is largely indistinguishable and unobtrusive. It is expected that the anticipated noise levels from either of the cooling tower options would not be significantly greater than background levels. It is anticipated that the heat dissipation system would have a noise level of up to 55 decibels at a distance of 300 m (1000 ft) from the system (Exelon 2006a). This level is below the typical outside noise criterion, 65 decibels, for residential areas (24 CFR Part 51).

Exelon states that a Hearing Conservation Program would be developed to control and protect onsite workers from excessive noise levels, which are defined as an 8-hour exposure of 85 decibels or more. The program would comply with the requirements specified in 29 CFR 1910.95 (Exelon 2006a). In addition, noise levels at a new nuclear unit would be governed in accordance with the following regulations:

- Occupational Safety and Health Administration (OSHA) noise-exposure limit to workers and workers' annoyance from the noise

- Consideration of acceptable noise levels for offices, control rooms, etc. (29 CFR Part 1910)

- Federal (40 CFR Part 204) noise-pollution control regulations

- State (35 Illinois Administrative Code Subtitle H) or local noise-pollution control regulations (35 IAC 2003, 2004, and 2006).

There are few rural families close to the site that might be affected by an increase in traffic noise generated by station employees' cars, delivery trucks, and offsite shipments. Traffic from the operation workforce driving to and from the site would increase the level of vehicular noise for those residents living along routes that access a new nuclear unit.

Traffic on the roads is controlled by speed limits. The staff assumes that access roads to the ESP site would be paved. Most vehicle trips are anticipated to occur during normal weekday business hours. Given that these are rural roads, lightly traveled and with appropriate speed limits, it is anticipated that even with the added traffic, noise levels would be below the noise criteria for residential areas (24 CFR Part 51).

A new nuclear unit could have standby diesel generators for auxiliary power. The generators would be required to have air-emission permits, which would ensure their compliance with applicable Federal and State air-pollution requirements. Also, it is expected that these generators would see limited use and, if used, would be used for only short periods of time (Exelon 2006a).

In summary, it is expected that offsite noise impacts would be minor because of the noise-control devices on the vehicles, the adherence to applicable State and Federal criteria, the distance of nearby residences to the site, and the fact that operations activities entailing significant noise would be limited to normal weekday business hours. Exelon has stated it would adhere to applicable air-pollution control regulations as they relate to the operation of fuel-burning equipment. In addition, central Illinois is in attainment[a] or is an unclassified[b] area for the criteria pollutants. Therefore, based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the physical impacts of station operation on the workers and the local public would be SMALL, and mitigation would not be warranted.

5.5.1.2 Buildings

DeWitt and Weldon are the two closest small towns to the Exelon ESP site and are located 5 and 8 km (3 and 5 mi), respectively, from the site. No physical impacts from operation of a new nuclear unit would affect these two rural communities, which include small businesses, houses, and farms. No physical impacts to structures, including residences near the site or vicinity, are anticipated from operation of a new nuclear unit on the ESP site.

Therefore, based on the staff's independent verification during a site visit the week of March 1, 2004, the staff concludes that the physical impacts of station operation on offsite buildings would be SMALL, and mitigation would not be warranted.

(a) "Attainment" means that an area meets applicable air-pollution standards (EPA 2006).
(b) "Unclassified" means that an area cannot be classified as meeting or not meeting the applicable air-pollution standards (CARB 2003).

5.5.1.3 Roads

The roads and highways in the vicinity of the site would experience an increase of approximately 580 additional vehicle trips per day, in addition to the 550 vehicle trips per day associated with the existing CPS operating workforce. The roads and highways are two-lane, well-maintained, rural, and lightly traveled. Given that they are expected to handle an even heavier construction-labor workforce without undue congestion, it is expected they could also withstand the increase in vehicular traffic of the permanent operating workforce.

Based on the information provided by Exelon and the staff's independent verification during a site visit the week of March 1, 2004, the staff concludes that the physical impacts of station operation on roads in the vicinity of the site would be SMALL and mitigation would not be warranted.

5.5.1.4 Aesthetics

A new nuclear unit would marginally change the view existing from the current CPS operating facility. The CPS has a power-block structure approximately 60 m (200 ft) tall, and a new nuclear unit at the ESP site would have a power block structure that could be up to 71.3 m (234 ft) tall. The heat dissipation system could have a height of up to 168 m (550 ft). An off-gas structure might also be required and would range in height between that of the power block structure and the height of the heat dissipation system. An additional visible plume might result from the heat dissipation system. Occasionally during cold weather, vapor/moisture plumes from the towers might be visible from some offsite locations, depending on wind direction and other meteorological parameters (Exelon 2006a).

A new nuclear unit on the Exelon ESP site would not substantially alter an already visually disturbed CPS site. The CPS and a new nuclear unit would be visible from several vantage points around the site and outside the site boundary. However, the Exelon ESP site is far removed from most of the permanent population, with the closest residence approximately 1.2 km (0.73 mi) to the southwest and the closest town, DeWitt, which is approximately 5 km (3 mi) to the east. Recreational users of Clinton Lake would be able to observe the operation of the new unit only by the visible moisture plumes from the heat dissipation units that may appear under certain meteorological conditions. Users of the lake would be able to see the CPS and new nuclear unit from certain parts of the lake.

There is a concern about the impact of the facility's cooling system on lake levels during times of severe drought. The consumptive water loss to the atmosphere from the cooling tower, added to the existing consumptive loss of the CPS once-through cooling system during times of drought, could lower the water levels of the lake significantly.

In summary, a new nuclear unit at the Exelon ESP site would have visual impacts similar to those of the existing CPS. As the area is sparsely populated, the facility would have a minor (small) impact on aesthetic quality for nearby residences and on recreational users of Clinton Lake. However, the impacts could also be moderate due to the consumptive use of water for cooling and impacts on Clinton Lake during times of severe drought. Therefore, based on the information provided by Exelon and the staff's independent verification during a site visit the week of March 1, 2004, the staff concludes that the physical impacts of station operation on aesthetics would be SMALL and mitigation would not be warranted. During times of severe drought the impacts would be MODERATE, and mitigation would not be generally warranted due to the temporary nature of the potential impact.

5.5.2 Demography

Population within an 80-km (50-mi) radius of the region is 764,366 and projected to grow to 942,556 by 2060, for a total increase over the 60-year period of 23.3 percent (see Table 2-6). The economy in the region is considered recovering from the economic recession of 2001.

There are an estimated 550 permanent operating personnel employed at the CPS site (Exelon 2006b). Approximately 580 additional permanent workers would be required for the operation of a new nuclear unit (Exelon 2006a). Exelon expects that most of the new operating workforce will come from within the region (Exelon 2006a). But even if the 580 additional employees and their families were to come from outside the region, the potential increases in population of the most impacted counties would not be significant. For example, the 580 additional employees would translate into an increase in population of about 2320, assuming each new employee represents a family of four. Assuming that the geographic distribution of new employees would be the same as for the existing employees of the CPS (see Section 2.8.2), about 190 new employees would settle in DeWitt County, 140 in Macon County, and 120 in McLean County. The remaining approximately 130 employees would be scattered throughout the other counties within the 80-km (50-mi) radius of the Exelon ESP site.

The addition of the new employees and their families would equate to the following percentage increases in population (using 2000 Census data; see Table 2-8): DeWitt County 4.5 percent, Macon County 0.49 percent, and McLean County 0.32 percent. Overall, the potential increases in population do not represent a large percentage increase in the total population for the most impacted counties.

Some new jobs might result from employment of the new operating personnel through the multiplier effect attributable to the operations workforce. But when these increases are compared to the total population base in the region, it is expected that they would be minimal as well. And many of these new jobs would be filled by workers already living within the region.

In summary, the number of new employees and their families would represent a very small increase to the counties' total population. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of station operation on increases in population would be SMALL and mitigation would not be warranted.

5.5.3 Impacts to the Community

This section evaluates the social, economic, infrastructure, and community impacts to the surrounding region as a result of operation of a new nuclear unit. The evaluation assesses impacts of operation and of those demands placed by the workforce on the surrounding region. Operation of a new nuclear unit could last up to 60 years (a potential 40-year initial operating license, plus 20 years additional operation under license renewal) and employ up to an additional 580 workers (Exelon 2006a). This is in addition to the 550 permanent operations personnel currently employed at the CPS site (Exelon 2006b).

5.5.3.1 Economy

The impacts of station operation on the local and regional economy are dependent on the region's current and projected economy and population. Some insight can be obtained on the projected economy and population by consulting county comprehensive plans and data from the U.S. Census Bureau. The economic impacts, given the potential 60-year period of station operation, are qualitatively discussed below.

Exelon states that it is expected that most new operating personnel would come from inside the region (Exelon 2006a). The employment of the operations workforce for such an extended period of time (i.e., potentially 60-year operating life of the facility) would have economic and social impacts on the surrounding region. DeWitt County would be the most impacted, and Piatt County might be the second most impacted in percentage terms (the relationship of the net economic benefits of a new nuclear unit to the total economy of the county). Further impacts become diffuse as a result of interacting with the larger economic base of the surrounding counties and cities. Impacts would affect traffic, taxes, housing, and public services, among others, all of which are discussed separately below. The magnitude of the impacts hinge on (1) the percentage of the workforce that would come from within the region of interest (80 km [50 mi]) and thus commute to the site and (2) those workers who might relocate to the area and whether they would relocate to DeWitt and Piatt Counties or elsewhere in the region.

The economic impacts to the region would be beneficial. The new jobs, as with the construction workforce, would also create new jobs in the region through the multiplier effect.

Any multiplier effect resulting from the operating personnel expenditures in the region would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity.

In summary, the magnitude of the economic impacts would be diffused in the larger economic bases of Macon, McLean, and Champaign Counties. DeWitt County would be the site of a new nuclear unit and would benefit more, as a result, than Piatt and Logan Counties. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of station operation on the economy would be beneficial and SMALL everywhere in the region except DeWitt County, where the impacts could be MODERATE, and that mitigation would not be warranted.

5.5.3.2 Taxes

There will be several types of taxes generated by the increase in the permanent operations workforce at a new nuclear unit at the Exelon ESP site. These include income taxes on corporate profits and on wages and salaries paid, sales and use taxes on purchases, and property taxes on owned real property. Each is briefly discussed below. Taxes collected are viewed as a benefit to the State and the local jurisdictions in the region.

Personal and Corporate Income Taxes

As discussed in Section 4.5.3.2, Illinois has a personal and corporate income tax. Employees of a new nuclear unit would pay taxes on their wages and salaries to Illinois if their residence is in Illinois. Exelon would also pay Illinois a corporate income tax on the profits received from the facility. While the exact amount of tax payable to Illinois is not known, it could be substantial over the potential 60-year life of the operating facility. Although the amount of taxes collected over the potential lifetime of the project could be large in absolute amounts, it is small when compared to the total amount of taxes Illinois collects in any given year or over the 60-year period.

Sales and Use Taxes

Illinois and the counties surrounding the Exelon ESP site would experience an increase in the amount of sales and use taxes collected as a result of the operation of a new nuclear unit. Additional sales and use taxes would be generated by retail expenditures (restaurants, hotels, and motels, merchant sales, and food) of the operating workers.

At this point, it is difficult to assess which counties and local jurisdictions would be most impacted by the expenditures and resultant sales and use taxes collected. In absolute terms, the amount of taxes collected over a potential 60-year operating period could be large, but small when compared to the total amount of taxes collected by Illinois and the governmental jurisdictions within the region. The exception could be Clinton, which is close to the Exelon ESP site and would be a convenient shopping point for the workforce at the new nuclear unit. In addition, approximately 33 percent of the current CPS employees live in DeWitt County. Should this pattern be replicated with the operating workforce of a new nuclear unit, it is probable that Clinton could receive a large increase in taxes collected. Because towns of significant size are 30 km (20 mi) or more from the site, it would be more likely that workers would seek services and make purchases at locations closer to the Exelon ESP site.

Property Taxes

A main economic impact related to the operation of an additional unit would be associated with payment of property taxes. The value of an additional unit would exceed that of the CPS, which has depreciated with time and deregulation (see discussion in Section 2.8).[a] It is not possible to estimate the actual amount of taxes on the new facility that would be paid to DeWitt County and to other jurisdictions in the county. DeWitt County, Clinton Community School District No. 15, and the other taxing districts listed in Section 2.8.2.2 would be the beneficiaries of these taxes.

As previously stated, the full potential effects of electric utility deregulation in Illinois are not known at this time. Before deregulation, the property taxes paid by the CPS represented more than 70 percent of the total property taxes received by DeWitt County. During the transition period, as a result of deregulation, they still represent more than 50 percent of the total property taxes collected by the County as of 2002 (see Table 2-15). It is expected that the addition of a new nuclear unit would represent a significant source of property tax revenue for the County, even with deregulation.

The second source of property taxes would be on the housing owned by the permanent employees at a new nuclear unit. The operating workforce would consist of up to 580 employees. Exelon expects that, while some of the workforce might relocate from outside the region, a significant number of them would already be located in the region. Exelon bases its conclusion on the fact that a significant number of employees at the CPS already lived within the region before operations at that facility began and did not move to the vicinity but remained in the region (Exelon 2006a).

If Exelon's assumptions are true, there would not be a substantial shift or increase in property taxes paid from housing within the region and vicinity. Some potential employees might move up to more expensive housing because of better paying jobs, but this would be a minor economic perturbation within the regional economy.

(a) A current (January 2006) discussion of deregulation can be found in Section 2.8.2.2.

However, if Exelon's assumptions do not hold, two things could happen. First, if the available workers with the requisite skills could not be found within the region, they would be recruited from outside and move into the region. Some new workers could construct new housing or increase the demand for existing housing, which could put some upward pressure on housing prices, increasing values and property taxes paid, particularly DeWitt County. New construction, even without upward pressure on housing values, would add to the property tax base. If this addition to the tax base were to occur in the larger cities in the region, the increase in property taxes paid, though important and large when aggregated over time, would be insignificant when compared to the total taxes collected by these jurisdictions.

On the other hand, in the smaller jurisdictions, such as DeWitt, Piatt, and Logan Counties, the effects could be more significant. Approximately 33 percent of CPS employees live in DeWitt County. If 33 percent of the permanent employees for a new nuclear unit decided to move to and live in DeWitt County, it would account for about 190 families. However, at the present time, there is no housing of the right type available in DeWitt County to accommodate this increase. New housing construction would have to be undertaken to meet the demand. Because of the increased demand for housing, it could be expected that prices of existing housing would rise (thus increasing property values and property taxes, as well) and constructed new housing would be added to the tax rolls. DeWitt County (and the other surrounding counties to a lesser extent) would benefit from increased property values and the addition of new houses to the tax rolls. A more complete discussion of housing impacts is found in Section 5.5.3.5.

At this time, it is not possible to know whether Exelon's assumptions about the new permanent operating workforce coming from within the region will hold up or not, nor of the magnitude of property taxes that might be collected on new or existing residential housing as a result of the additional operations workforce.

Summary of the Impact of Taxes

The staff evaluated the effect of taxes from income on wages and salaries of Exelon employees, and sales, use, and property taxes of these employees, as well as taxes on Exelon's corporate profits. These represent beneficial sources of income for the State, some of which would benefit the counties in the region. Property tax paid by Exelon would directly benefit DeWitt County, (and other jurisdictions currently receiving property from AmerGen and, as a result, the proposed new nuclear unit), as would property taxes from employees living in the county. Sales and use taxes could beneficially impact the City of Clinton, due to its proximity to a new nuclear unit. Personal and corporate income taxes would be paid to the State of Illinois. Although the amount of taxes collected over the potential lifetime of the project could be large in absolute amounts, it is small when compared to the total amount of taxes Illinois collects in any given year or would collect over the 60-year life of operation of a new nuclear unit. Based on a review of the overall impacts on the region, the beneficial impacts would be SMALL to LARGE (DeWitt County) and mitigation would not be warranted.

5.5.3.3 Transportation

The roads and highways within the vicinity of the Exelon ESP site would experience an increase in use of approximately 580 additional vehicle trips during the peak hours of the workday. This is in addition to the 550 existing vehicles of the CPS workers, bringing the total vehicle trips from the combined CPS and new nuclear unit to 1130, assuming one employee per vehicle (Exelon 2006a). In addition, for a period of up to three weeks on an average 24-month cycle, from 1000 to 1300 temporary workers (the proposed new nuclear unit and CPS, respectively) would be employed during refueling outages (Exelon 2006b). The majority of the impacts would be the congestion at shift changes.

Most of the roadways within DeWitt, Logan, and Piatt Counties are rural and, as the staff observed during the site visit (March 1 to 5, 2004), lightly traveled and well-maintained. While population growth could put pressure on the local transportation system, it probably would not overwhelm the current transportation system in these counties. Upon leaving the ESP site, workers are expected to travel and disperse in all directions (Exelon 2006a). In addition, as discussed in Section 2.8, business route U.S. 51 through Clinton has had a center turn-lane constructed, which has greatly alleviated congestion through Clinton.

In summary, the rural roads are well maintained and lightly traveled. The addition of the workforce to operate a new nuclear unit would cause congestion only at shift changes. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of station operation on the transportation system would be SMALL and that mitigation would not be warranted.

5.5.3.4 Recreation

There are four issues with respect to recreation at Clinton Lake. First is the impact of a new nuclear unit, in conjunction with the existing CPS, on Clinton Lake's water quality and temperature and, in turn, their impact on recreation. Second is the impact on recreation because of the potential increase in the use of the lake as a result of hiring the operations workforce. Third is the potential consumptive loss of water in Clinton Lake during a severe drought as a result of a new nuclear unit's cooling system. Fourth is the potential health impacts a new nuclear unit's cooling system might have on users of the lake. Changes in the recreational use of Clinton Lake could have economic impacts to the surrounding area. The following discussion addresses the first three issues. The fourth issue concerning potential health impacts is discussed in Section 5.8.1 of this EIS.

Clinton Lake is cited in Illinois 2004 Section 303(d) (IEPA 2004), which identifies it as an impaired waterbody (Exelon 2006a). Impaired water quality (including both metals and sediments) can impact recreational use of the lake. The causes of impaired use include excess algal growth and metals. Algal growth is related to nutrient levels in the water column that originate from the dominant agricultural land use and crop production. Other sources may also contribute to the availability of nutrients in the water column, such as recreational boating, which may increase sediment resuspension and shoreline erosion. Power plant operation is not considered a significant source of nutrients to Clinton Lake (Exelon 2006a). Metals concentrations in the water column and sediment have a number of sources, including natural geologic formations, agricultural practices, and industrial sources. The CPS, an industrial source, is also a potential source of metals (Exelon 2006a).

For both impairments (sediments and metals), storm water management and erosion-control practices for sediment control are the best control options. Nutrients and metals attach to the sediments and are effectively controlled with control of sediments in storm water. Industrial pollution-control practices, strategic materials selection, and corrosion control are also expected to be effective in reducing metals contributions from industrial sources.

The second issue is the impact an increase in the operations workforce for a new nuclear unit might have on Clinton Lake and other nearby facilities, such as Weldon Springs, due to increased crowding. If the workforce to be hired was already in the region and did not relocate to DeWitt County and the City of Clinton, there would be minimal impact on the recreation taking place at Clinton Lake and nearby facilities. However, if the workforce was recruited from outside the region or if there was a relocation of existing operating personnel to Clinton and DeWitt County, there could be increased demand for the recreational services provided by the lake and other facilities. Currently, 33 percent of the CPS workforce resides in Clinton or DeWitt County. Given an expected operating workforce at a new nuclear unit of 580 individuals with an assumed 33 percent moving to Clinton or DeWitt County, there could be 190 new families (or 760 individuals, assuming four individuals per family) moving into these areas. This could result in increased crowding, a decline in overall recreational enjoyment, and potentially a decrease in water quality which, in turn, impacts the recreational experiences at these facilities.

The third issue is potential impairment of recreation on the lake due to lower water levels during periods of severe drought. The consumptive water loss to the atmosphere from the cooling tower of a new nuclear unit could lower the water levels of the lake significantly during times of drought. This could impact both boating (lower water levels) and fishing (lower water levels and elevated temperatures) at the lake. One mitigating factor at Clinton Lake is that the steep banks might mean less land exposed during drops in the pool elevation. Another is that a drought severe enough to impact lake levels and water quality is a rare event.

In summary, severe drought in conjunction with the consumptive use of water for cooling at both the CPS and a new nuclear unit could impact lake pool elevations and temperature, which in turn could impact boating and fishing. A drought severe enough to impact lake levels and water quality is a rare event. Mitigative actions could include reducing the power output or shutting down the CPS and/or the proposed new nuclear unit. The impacts of the operating workforce on Clinton Lake and other nearby recreational facilities hinge on whether the operating workforce would come primarily from within the region (with most staying at their existing places of residence and commuting to a new nuclear unit) or would relocate to DeWitt County and Clinton to be nearer work. If the latter, then the recreational experience at Clinton Lake could deteriorate, which would cause those recreationists using the lake to look elsewhere, lessening the demand on the lake for recreation – a form of mitigative action. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that potential impacts of station operation on recreation would be SMALL to MODERATE. Mitigation would be warranted only when a drought occurs and could be undertaken by changing the way in which the proposed new and existing nuclear unit is operated.

5.5.3.5 Housing

An accurate estimate of the number of housing units that would be available in the region in the year a new nuclear unit would begin operation is not possible. If Exelon's assumptions hold and the operational workforce of 580 already reside in the region and do not relocate closer to the new nuclear unit, then housing supply within the region would be more than adequate to meet the needs of a small number of operating employees relocating from outside the region.

Otherwise, it all depends on where the potential new growth takes place, as discussed in Section 5.5.3.2. Again, while there is no way of accurately estimating the number of available housing units at the commencement of operations, Section 2.8.2 reviews the current availability of housing in the region. Table 2-17 shows that the availability of vacant housing units in the region could easily accommodate the expected permanent workforce of 580 new employees. In 2000, there were 13,183 vacant housing units in Champaign, DeWitt, Logan, Macon, McLean, and Piatt Counties. The counties in the vicinity of the Exelon ESP site and within the region are addressing the needs of the projected increases in population through their county comprehensive plans. As such, an adequate number of housing units likely would be available, especially in the larger towns.

Currently, in smaller towns and counties around the Exelon ESP site, the housing market is much tighter. In 2000, there were 1594 vacant housing units in DeWitt, Piatt, and Logan counties and, of those, 155 were for sale in Clinton, Farmer City, Monticello, and Lincoln. Clinton had 37 houses for sale on the market in 2000 (see Table 2-18) and DeWitt County had 97 (USCB 2000b). While in absolute numbers there would be enough housing to accommodate 190 new families, not all units would necessarily be the type of housing purchased by higher income families, as most likely would be representative of the permanent operating workforce at the Exelon ESP.

With respect to housing prices, DeWitt County does not have a growth moratorium. Given that the incomes of the new workforce would be expected to be higher than the overall average incomes in DeWitt, Piatt, and Logan Counties, the prices that the operations workforce would be willing to pay for housing would be expected to be on the high end of the price range within those counties. Therefore, it is expected that the impact on housing prices of workers relocating to these counties, especially to DeWitt County, would be impacted, and new construction would most likely have to be undertaken to meet demand. However, the abundance of existing housing within the surrounding region could mitigate against some of the effects on residential housing prices as a result of the increase in the operations workforce.

In summary, county comprehensive plans could address the issue of new housing, but there has been a history in the counties closer to the Exelon ESP site of generally not building “spec” housing (see Section 2.8.2.1). Therefore, advanced existing and new construction to handle potential population increases might not occur in a timely manner. One potential reason for the lack of “spec” building is that Piatt, Logan, and DeWitt Counties have had negative population growth during the 1990s (see Table 2-8). Based on the information provided by Exelon and the staff’s independent review, the staff concludes that potential impacts of a new nuclear unit on housing would be SMALL in the region and potentially MODERATE in DeWitt, Piatt, and Logan Counties. The MODERATE impact rating depends on whether the operations workforce comes from outside the region and/or locates in DeWitt, Piatt, or Logan counties to be nearer the work site at the proposed new nuclear unit. Market forces, represented by increased housing demand, would result in more housing being built, which, over time, would mitigate any housing shortages.

5.5.3.6 Public Services

This section describes the impacts of a new nuclear unit at the Exelon ESP site on local and regional water supplies and waste water treatment; on police, fire, and medical facilities; and on social services.

Water Supply and Waste Water Treatment

In the vicinity of the Exelon ESP site in DeWitt County, drinking water is primarily obtained from municipal groundwater sources via wells. Only a small number of residents have private well systems. The Clinton Sanitary District Sewage Treatment Plant serves the waste water needs of the City of Clinton. In the region, rural communities generally have private wells for water and septic systems for sanitary wastes. Larger communities obtain water from groundwater extraction wells or lakes and are served by public waste water treatment systems. A survey was performed for water and waste water facilities in the region, and the facilities have excess capacity to accommodate potential population increases (Exelon 2006a). Within the last decade, Clinton has upgraded its waste water system and now has excess capacity. An independent analysis conducted by the NRC staff confirmed Exelon's conclusion (see Tables 2-19 and 2-20).

Public water supply and waste water treatment are not a constraint to growth in the vicinity of the Exelon site, assuming that growth increases hold to the historical norm. Should there be a disproportionate increase in the populations of Clinton, Monticello, or Farmer City as a result of relocation of the operations workforce within the region or the importation of workers into Clinton and DeWitt Counties, there could be some capacity constraints. One potential restraint to this happening is the small number of vacant housing units available in these small towns.

Police, Fire, and Medical Facilities

Section 4.5.3.6 discusses the availability of police, fire, and medical facilities in the region. Exelon concludes that the projected capacity of these public services is adequate and is expected to expand modestly to meet the demands of a slight population growth (Exelon 2006a). The fact that annual population growth projections are less than 0.8 percent (Champaign County 2000 to 2010) a year within the region tends to support its conclusion (see Table 2-8). Exelon plans to employ its own security force for a new nuclear unit on the ESP site (Exelon 2006a).

If 190 workers were to locate to Clinton and/or DeWitt County, there could be some pressure on fire-protection providers. The degree of pressure would be dependent on where these workers locate, whether in developed areas such as Clinton, where fire services are already provided, or in the county, where the services might not be available but could be provided given a demonstrated need. The increased property taxes coming from a new nuclear unit could help fund such services. Medical facilities within the larger communities are within commuting distance of the smaller communities.

Social Services

This section focuses on the potential impacts of station operation on the social and related services provided to disadvantaged segments of the population in DeWitt County. This section is distinguished from issues surrounding environmental justice, which is discussed in more depth in Section 5.7.

Station operation would be viewed as beneficial economically to the disadvantaged population served by the Department of Human Resources in DeWitt County. Station operation might enable the disadvantaged to improve their social and economic position by moving up to higher paying jobs created by the multiplier effect of station-operation jobs. Based on where the current operations workforce for the CPS lives and given that new employees would follow similar location patterns, many of these benefits could accrue to DeWitt County, where, because of the smaller economic base, they might have a more noticeable impact.

Summary of Public Services

In summary, a survey was performed for water and waste water facilities in the region, and the facilities have excess capacity to accommodate potential population increases. The projected capacity of police, fire, and medical services in the region is currently adequate and is expected to expand modestly to meet the demands of a slight population growth. The increases in tax revenue could help with the infrastructure and resource requirements for any potential increase in demand for services (police, fire, etc.). Station operation would be beneficial economically to the disadvantaged population served by the Department of Human Resources in DeWitt County, enabling them to improve their social and economic status, thereby potentially cutting back on the amount of social services required. Therefore, based on the information provided by Exelon and the staff's independent evaluation, the staff concludes that the potential impact on the demand for public services as a result of a new nuclear unit would be SMALL and that mitigation would not be warranted.

5.5.3.7 Education

Exelon undertook a survey of class size of some schools within the region and concluded that there is sufficient capacity for a small increase in school population (Exelon 2004b, 2006a). When NRC staff interviewed the superintendents of the Clinton and Monticello School Districts, overcapacity in the number of students per class room was not an issue.[a] At least locally this would tend to support Exelon's conclusions that there is a sufficient capacity in the education system to handle a small increase in population. Exelon assumes that the majority of the operations workforce would come from within the region, where educational requirements are already being met. Thus, the school systems in these areas would not experience any major influx of students because of the operation of a new nuclear unit (Exelon 2006a).

Even if some of the operating workforce were to come from outside the region, the majority of the new workers would likely move to the more populous areas in the surrounding communities, having access to the more developed public services. Workers with school-aged children

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(a) Personal interviews conducted on March 3, 2004, in the City of Clinton with Roger A. Little, Superintendent, Clinton Unit School District 15, and on March 5, 2004, in the City of Monticello with Lawrence J. McNabb, 2004, Superintendent, Monticello Community School District 25.

would be interested in communities with good school districts, for example. There are a number of private schools located in the region, which would further increase educational options for incoming workers and their families.

Should workers relocate to Clinton and DeWitt County to be closer to a new nuclear unit, the local school district could accommodate an increase in the student population. Should there be small adverse impacts to local school districts due to the influx of plant workers into a community, these would likely be at least partially offset by increased sales, property, and income tax revenues paid by facility personnel, which in turn could be used to build additional classrooms or schools to accommodate the increased student population.

The majority of the operations workers are expected to come from within the region, with little anticipated in-migration of operations workers from outside. Should workers come from outside the region, they might commute to the site from the larger cities in the region. Should they relocate to Clinton and DeWitt County to be closer to the site, it would appear that the local school district could accommodate an increase in the student population. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impact of the operation of a new nuclear unit on educational facilities would be SMALL and that mitigation would not be warranted.

5.6 Historic and Cultural Resource Impacts

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966, as amended through 2000 (NHPA), also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (such resources are referred to as "Historic Properties" in NHPA). As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC coordinated compliance with Section 106 of the NHPA in meeting the requirements of NEPA.

The NRC has determined that evaluating suitability of a potential ESP unit within the existing CPS site for construction, operation, and decommissioning of a new nuclear unit is an undertaking that could possibly affect either known or potential historic properties that may be located at the site. Therefore, in accordance with the provisions of NHPA and NEPA, the NRC is required to make a reasonable and good faith effort to identify historic properties in the areas of potential effect and, if present, determine if any significant impacts are likely to occur. Identification is to occur in consultation with the State Historic Preservation Officer, American Indian tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, if no historic properties (i.e., places eligible for listing on the National Register of Historic Places) are present or affected, the NRC is required to notify the State Historic Preservation Officer before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve adverse effects of the undertaking.

For specific historic and cultural information on the Exelon ESP site, see Section 2.9.

The staff does not expect any significant impacts on cultural and historic resources during ESP unit operation. Any new ground-disturbing activities that might occur during operation would follow Exelon procedures, which would require further evaluation to determine if additional archaeological review is necessary (Exelon 2006a). Therefore, the staff concludes that the impacts from operations would be SMALL. Mitigation might be warranted in the event of an inadvertent discovery.

5.7 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. In 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040 and NRC 2004c). Section 2.10 discusses the locations of minority and low-income populations around the Exelon ESP site and within the 80-km (50-mi) radius.

The staff identified the pathways through which the environmental impacts associated with operating a new nuclear unit at the Exelon ESP site could affect human populations. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. During its March 2004 site audit, the staff interviewed local government officials and the staff of social welfare agencies concerning potentially disproportionate impacts to minority and low-income populations. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately impacted by operation of a new unit that would result in those populations being adversely affected. In addition, the staff did not identify any location-dependent disproportionate impacts affecting these minority and low-income populations.

In summary, no disproportionately high or adverse health or environmental effects impacting minority or low-income populations were found. Therefore, based on the information provided by Exelon and the staff’s independent review, the staff concludes that the offsite impacts of station operation of a new nuclear unit at the Exelon ESP site to minority and low-income populations would be SMALL, and mitigation would not be warranted.

5.8 Nonradiological Health Impacts

This section addresses the health impacts of operating a new nuclear unit at the Exelon ESP site from nonradiological parameters. Health impacts to the public from the cooling system, noise generated by operations, and EMFs are discussed. Health impacts from the same sources are also evaluated for workers at a new nuclear unit. Health impacts from radiological sources during operations are discussed in Section 5.9.

5.8.1 Thermophilic Microorganisms

In its ER, Exelon notes that lake temperature appears to be the most significant water quality change from CPS operations (Exelon 2006a). Lake cooling is the primary cooling process used by the CPS. Heated non-contact cooling water is cooled by contact with the soil and air as the water passes down the 5.5-km (3.4-mi) discharge flume and around the Clinton Lake cooling loop back to the plant intake.

The new nuclear unit would use either wet cooling systems (i.e., mechanical or natural draft cooling towers) or a combination of hybrid wet/dry cooling systems. The impact of this type of cooling process would not be significant for water temperature in Clinton Lake when compared to the open-cycle cooling process (i.e., cooling lake) used for the CPS. Lake temperature increases from cooling tower blowdown are not expected to be significant. Changes in lake temperature can increase the number of thermophilic microorganisms. Thermophilic microorganisms include enteric pathogens such as *Salmonella sp., Pseudomonas aeriginosa,* and *thermophilic fungi*, bacteria such as *Legionella sp.,* and free-living amoeba such as *Naegleria fowleri* and *Acanthomoeba*. These microorganisms could be causative agents of potentially serious human infections. However, the small temperature increase expected as a result of operating the new nuclear unit would not significantly increase the abundance of these organisms and the staff concludes that the impacts on human health would be SMALL and that no mitigation would be warranted.

5.8.2 Noise

In the GEIS (NRC 1996), the staff discusses the environmental impacts of noise at existing nuclear power plants. Common sources of noise from plant operation include cooling towers, transformers, and loud speakers with intermittent contributions from auxiliary equipment. These noise sources are generally sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near-ambient levels before reaching critical receptors outside the plant boundary.

The existing unit at the CPS has an open-cycle cooling system that uses water from Clinton Lake. This system does not contribute significantly to noise at the plant site or plant boundary.

Exelon's ER (Exelon 2006a) specifies that a new nuclear unit at the ESP site would be cooled by wet or hybrid wet/dry cooling towers. If the ESP was approved and cooling towers were used at the site, the towers would be a major noise source on the site.

The ER does not directly specify the sound intensity for cooling towers. However, the PPE specifies that cooling tower noise will be less than 55 decibels at 300 m (1000 ft). In general, the decrease in sound intensity with distance from the source is inversely proportional to the square of the distance. At its closest point of approach, the site fence line is approximately 90 m (300 ft) from the area where cooling towers would be located; the exclusion area boundary is about 520 m (1700 ft) from the cooling tower location, and the closest residence is about 730 m (2400 ft). Using these distances, the inverse square relationship, and the PPE cooling tower noise specification, the corresponding sound intensities at the closest points on the fence line, exclusion area boundary, and nearest residence are estimated to be approximately 65, 50, and 47 decibels, respectively. For context, Tipler (1982) lists the sound intensity of a quiet office as 50 decibels, normal conversation as 60 decibels, busy traffic as 70 decibels, and a noisy office with machines or an average factory as 80 decibels. Construction noise (at 3 m [10 ft]) is listed as 110 decibels, and the pain threshold is 120 decibels.

According to NUREG-1437 (NRC 1996), noise levels below 60 to 65 decibels are considered to be of small significance. More recently, the impacts of noise were considered in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG-0586, Supplement 1) (NRC 2002a). The criterion for assessing the level of significance was not expressed in terms of sound levels but based on the effect of noise on human activities and on threatened or endangered species. The criterion in NUREG-0586, Supplement 1, is stated as follows:

> The noise impacts ... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened or endangered species is affected.

Given the postulated noise levels for cooling towers, the staff concludes that the noise impacts would be SMALL and that mitigation would not be warranted.

5.8.3 Acute Effects of Electromagnetic Fields

EMFs are produced by electrical devices including transmission lines. Two issues related to the health effects of EMFs are addressed in some detail in NUREG-1437 (NRC 1996) relative to renewal of nuclear power plant operating licenses. Those issues are acute effects (shock hazard) and chronic effects (effects of long-term exposure).

Acute effects can result from direct contact with transmission lines. Transmission line construction practices minimize public access to the lines. Acute effects can also be caused by induced currents. The 1981 revision of National Electric Safety Code added criteria related to construction of transmission lines to minimize potential impacts associated with induced currents.

Section 3.7.5 of the ER (Exelon 2006a) discusses grounding measures that would be taken to minimize the acute effects of induced currents in structures near transmission lines. Section 3.7.2 of the ER ends with the statement that transmission system design, construction, and operation would comply with the relevant local, state, and industry standards, including the National Electric Safety Code and various American National Standards Institute of Electrical and Electronics Engineers standards. This includes standards for ground clearances, EMFs, and other factors.

Given these considerations, the staff concludes that the impacts associated with transmission line rights-of-way for a new nuclear unit at the Exelon ESP site would be SMALL and that no mitigation would be warranted.

5.8.4 Chronic Effects of Electromagnetic Fields

Research on the potential for chronic effects from 60-Hz EMFs from transmission lines was reviewed in NUREG-1437 (NRC 1996). At that time, research results were not conclusive. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. A NIEHS report (1999) contains the following conclusion:

> The NIEHS concludes that extremely low frequency-electromagnetic field (ELF-EMF) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to consider the potential impact as significant to the public. However, because conclusive information is not available, this issue is unresolved.

5.8.5 Occupational Health

In general, human health risks for a new nuclear unit are expected to be dominated by occupational injuries (e.g., falls, electric shock, asphyxiation) to workers engaged in activities such as maintenance, testing, and plant modifications. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards (29 CFR Part 1910), practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks for new nuclear unit operation. The staff assumes strict adherence to NRC, OSHA, and State safety standards, practices, and procedures during new nuclear unit operation.

Occupational health impacts from thermophilic microorganisms would be the same as those discussed in Section 5.8.1. Health impacts to workers from noise and EMFs would be monitored and controlled in accordance with the applicable OSHA regulations and would be SMALL.

5.8.6 Summary of Nonradiological Health Impacts

The staff evaluated health impacts to the public and the workers. Health risks to workers are expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts to the public and workers from thermophilic microoganisms, noise generated by unit operations, and acute impacts of EMFs would be minimal. Based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential impacts of nonradiological effects resulting from the operation of a new nuclear unit would be SMALL, and mitigation would not be warranted. The staff has not come to conclusions on the chronic impacts of EMFs; consequently, this issue is not resolved.

5.9 Radiological Impacts of Normal Operations

This section addresses the radiological impacts of normal operations of a new nuclear unit on the Exelon ESP site, including a discussion of the estimated radiation dose to a member of the public and to the biota inhabiting the area around the ESP site. Estimated doses to workers are also discussed. Radiological impacts were determined using the PPE approach where the bounding direct radiation and liquid and gaseous radiological effluents were used in the evaluation (see discussion in Section 3.2.3).

5.9.1 Exposure Pathways

The public and biota would be exposed to increased ambient background radiation from a nuclear unit via the liquid effluent, gaseous effluent, and direct radiation pathways. Exelon estimated the potential exposures to the public and biota by evaluating exposure pathways typical of those surrounding a nuclear unit at the ESP site. They considered pathways that could cause the highest calculated radiological dose based on the use of the environment by the residents located around a new nuclear unit (Exelon 2006a). For example, factors such as the location of homes in the area, consumption of milk from dairy cows in the area, and consumption of vegetables grown in area gardens were considered.

For the liquid effluent release pathway, the ER considered the following exposure pathways in evaluating the dose to the maximally exposed individual: (1) ingestion of aquatic food (i.e., fish), (2) direct radiation exposure from shoreline activities, and (3) direct radiation exposure from swimming and boating activities (see Figure 5-1). The irrigation and drinking water exposure pathways were not considered, as water from Clinton Lake and Salt Creek is not used for either irrigation or public drinking water. Population dose estimates for the public within 80 km (50 mi) of a new nuclear unit were not calculated for the liquid effluent pathway because Clinton Lake and Salt Creek are not a source of public drinking water and no commercial fishing is allowed on them. Liquid effluents were assumed to be released into Clinton Lake at the end of the 5.5-km (3.4-mi) discharge flume.

For the gaseous effluent release pathway, Exelon considers the following exposure pathways in evaluating the dose to the maximally exposed individual and to the population: (1) external exposure to the airborne plume (i.e., air submersion), (2) external exposure to contaminated ground, (3) inhalation of airborne activity (i.e., gaseous effluents), and (4) ingestion of contaminated agricultural products (see Figure 5-1).

Exelon (2006a) states that direct radiation from the condensate storage tank and skyshine from nitrogen-16 in the CPS turbine building would be the dominant source of direct radiation exposure to the public from the Exelon ESP site. Exelon assumes that contained sources of radiation at a new nuclear unit would be shielded and would not contribute to the external dose of the maximally exposed individual or the population.

Exposure pathways considered in evaluating dose to the biota are shown in Figure 5-2 and included

- Ingestion of aquatic foods
- Ingestion of water
- External exposure from water immersion or surface effect
- Inhalation of airborne radionuclides

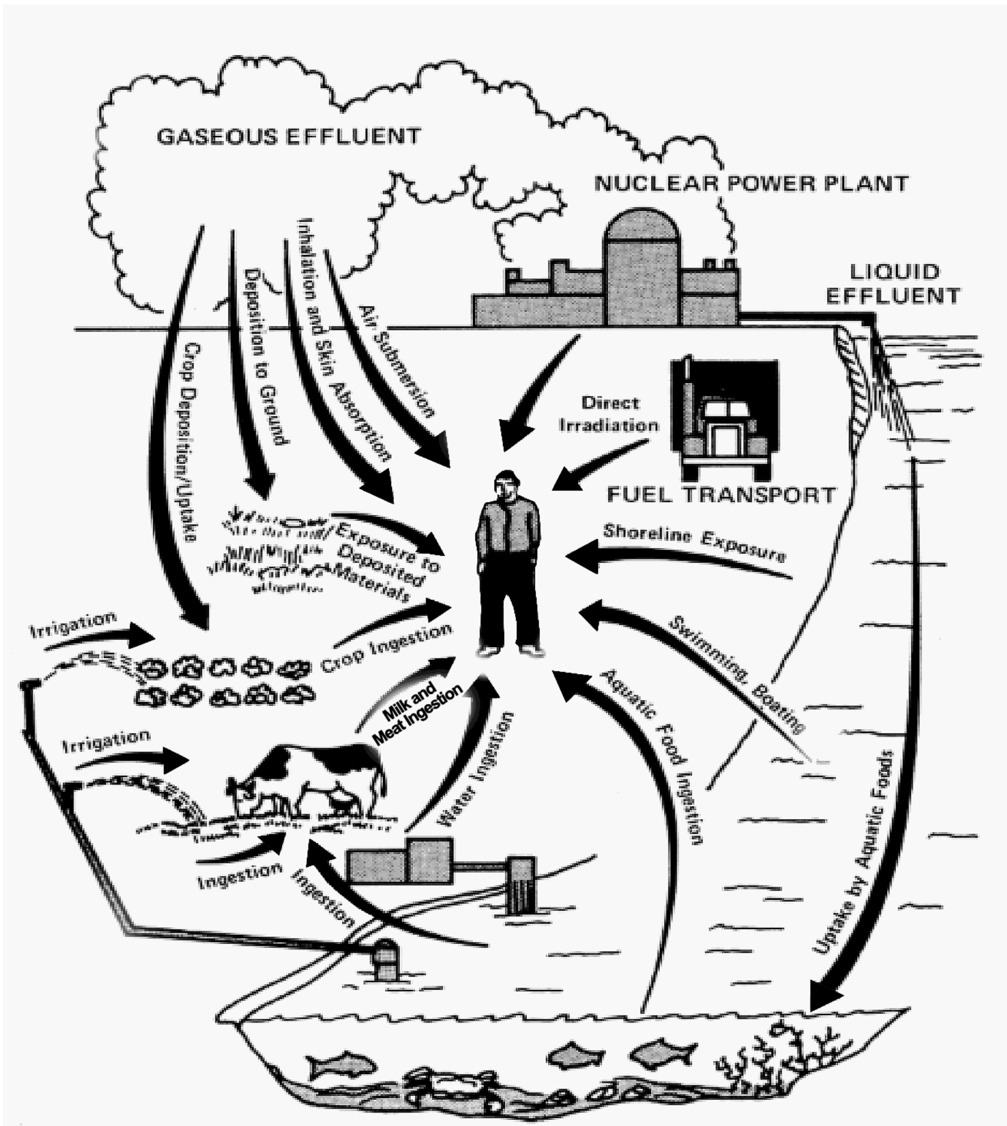

Figure 5-1. Exposure Pathways to Humans

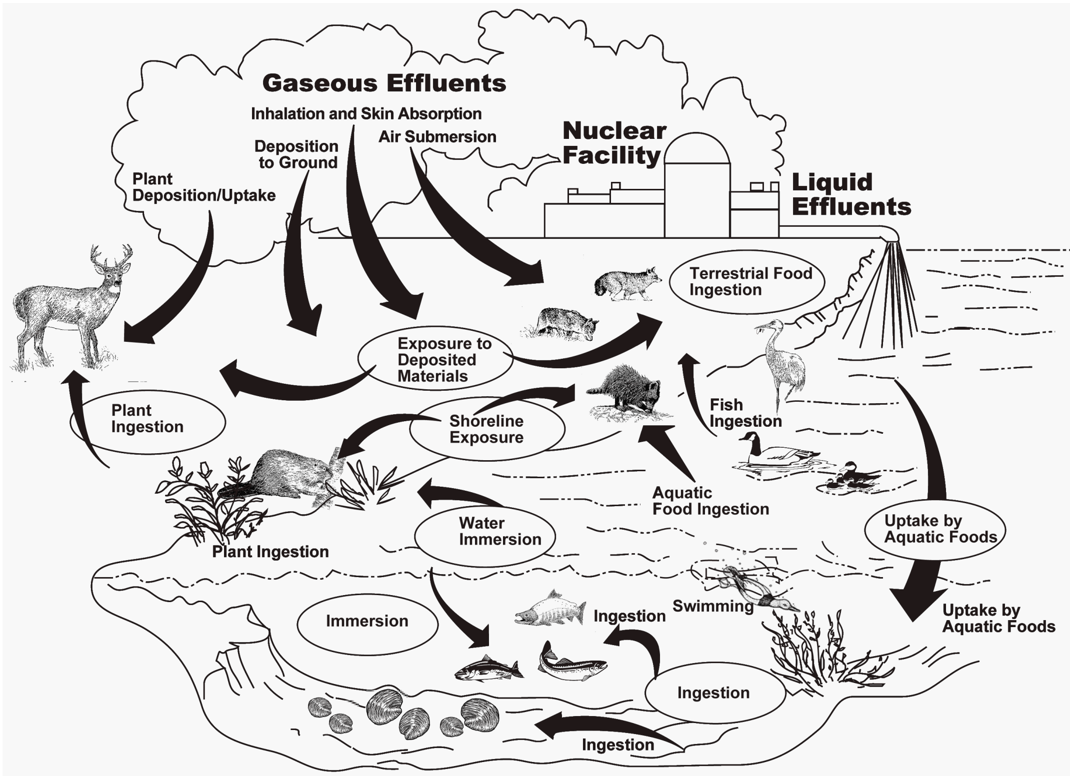

Figure 5-2. Exposure Pathways to Biota Other than Humans

- External exposure to immersion in gaseous effluent plumes, and
- Surface exposure from deposition of iodine and particulates from gaseous effluents (Exelon 2006a; NRC 1977).

The staff reviewed the exposure pathways for the public and biota identified by Exelon (2006a) and found them to be appropriate, based on a documentation review, a tour of environs, and interviews with Exelon staff during the site visit in March 2004.

5.9.2 Radiation Doses to Members of the Public

Exelon calculated the dose to the maximally exposed individual from both the liquid and gaseous effluent release pathways (Exelon 2006a). As discussed in the previous sections, direct radiation exposure to the maximally exposed individual from sources of radiation at a new nuclear unit would be negligible.

5.9.2.1 Liquid Effluent Pathway

Liquid pathway doses were calculated using the LADTAP II computer program (Strenge et al. 1986) for the following activities: eating fish caught near the discharge point, swimming and boating activities near the discharge point, and using the shoreline for recreational purposes near the discharge point. The liquid effluent releases used in the estimate of dose to the maximally exposed individual are found in Table 3.5-1 of the ER (Exelon 2006a). Other parameters used as inputs to the LADTAP II program include effluent discharge rate, dilution factor for discharge, lake volume, and liquid pathway consumption and usage factors (i.e., fish consumption, shoreline usage, swimming exposure, and boating) and are found in Tables 5.4-1 and 5.4-2 of the ER (Exelon 2006a).

Exelon calculated liquid pathway doses to the maximally exposed individual. The maximum annual dose to the total body for an adult was 0.0095 mSv (0.95 mrem). The maximum annual dose to the thyroid was 0.0003 mSv (0.03 mrem). The maximum annual dose to the liver for a teen was 0.0133 mSv (1.33 mrem).

The staff recognizes the LADTAP II computer program as an appropriate method for calculating dose to the maximally exposed individual for liquid effluent releases. The staff performed an independent evaluation of liquid pathway doses using input parameters from the ER and found similar results. All input parameters used in Exelon calculations were judged by the staff to be appropriate. Results of the staff's independent evaluation are found in Appendix H.

5.9.2.2 Gaseous Effluent Pathway

Gaseous pathway doses to the maximally exposed individual were calculated by Exelon using the GASPAR II computer program (Strenge et al. 1987) at the following locations: the nearest residence, nearest garden, nearest meat animal, nearest milk cow, nearest milk goat, and the exclusion area boundary. The GASPAR II computer program was also used to calculate annual population doses. The following activities were considered in the dose calculations: (1) direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, (2) inhalation of gases and particulates, (3) ingestion of milk and meat from cattle eating contaminated grass, and (4) ingestion of foods contaminated by gases and particulates. The gaseous effluent releases used in the estimate of dose to the maximally exposed individual and population are found in Table 3.5-3 of the ER (Exelon 2006a). Other parameters used as inputs to the GASPAR II program, including population data, milk production rates, vegetable production rates, meat production rates, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors, are found in Tables 5.4-3 and 5.4-4 of the ER (Exelon 2006a) or were obtained by the staff during the March 2004 site visit.

Gaseous pathway doses to the maximally exposed individual calculated by Exelon are found in Table 5-1. Table 5-2 shows the annual whole body and thyroid doses to the population from various pathways calculated by Exelon.

Table 5-1. Doses to the Maximally Exposed Individual from Gaseous Effluent Pathway[(a)]

Location	Pathway	Total Body Dose (mSv/yr)[(b)]	Thyroid Dose (mSv/yr)[(b)]	Skin Dose (mSv/yr)[(b)]
Exclusion area boundary (1.0 km [0.64 mi] NNE)	Plume	8.75×10^{-3}	-	2.94×10^{-2}
Nearest residence (1.2 km [0.73 mi] SW)	Plume	3.9×10^{-3}	-	1.4×10^{-2}
Nearest residence (1.2 km [0.73 mi] SW)	Inhalation			
	Adult	1.2×10^{-3}	4.8×10^{-3}	-
	Teen	1.2×10^{-3}	6.0×10^{-3}	-
	Child	1.1×10^{-3}	7.0×10^{-3}	-
	Infant	6.3×10^{-4}	6.0×10^{-3}	-
Nearest garden (1.5 km [0.93 mi] N)	Vegetable			
	Adult	2.7×10^{-3}	2.6×10^{-2}	-
	Teen	3.6×10^{-3}	3.6×10^{-2}	-
	Child	6.8×10^{-3}	7.0×10^{-2}	-
Nearest meat animal (1.5 km [0.93 mi] N)	Meat			
	Adult	6.1×10^{-4}	-	-
	Teen	4.5×10^{-4}	-	-
	Child	7.3×10^{-4}	-	-
Nearest milk cow (8.1 km [5 mi] N)[(c)]	Cow Milk			
	Adult	9.7×10^{-5}	1.5×10^{-3}	-
	Teen	1.4×10^{-4}	2.4×10^{-3}	-
	Child	2.7×10^{-4}	4.7×10^{-3}	-
	Infant	5.0×10^{-4}	1.1×10^{-2}	-
Nearest milk goat (7.1 km [4.4 mi] SE)[(d)]	Goat Milk			
	Adult	1.5×10^{-4}	1.7×10^{-3}	-
	Teen	2.0×10^{-4}	2.7×10^{-3}	-
	Child	3.4×10^{-4}	5.4×10^{-3}	-
	Infant	5.9×10^{-4}	1.3×10^{-2}	

(a) Source was the Exelon ER (2006a), Tables 5.4-6 and 5.4-9. No infant doses were calculated for the vegetable or meat pathway because the doses that infants receive from this diet would be bounded by the dose calculated for the child.
(b) Multiply mSv/yr times 100 to obtain mrem/yr.
(c) This distance and direction from the ESP site represents the location of the nearest cow producing milk for human consumption.
(d) This distance and direction from the ESP site represents the location of the nearest milk goat. In Table 2.7-54 of the ER (Exelon 2006a), the largest relative deposition factor for the nearest milk goat is listed at a distance of 8 km (5 mi) north-northeast of the ESP site. This relative deposition factor is approximately 20 percent greater than the relative deposition factor used in Exelon's calculation; however, it would not result in a significant increase in the dose to the maximally exposed individual.

Table 5-2. Annual Doses to Population from Gaseous Effluent Pathway[a]

Pathway	Calculated Dose to Total Body (person-Sv/yr)[b]	Calculated Dose to Thyroid (worst case organ) (person-Sv/yr)[b]
Plume	4.03×10^{-3}	4.03×10^{-3}
Ground	1.45×10^{-3}	1.45×10^{-3}
Inhalation	4.80×10^{-3}	1.53×10^{-2}
Vegetable ingestion	1.08×10^{-3}	1.09×10^{-3}
Cow milk ingestion	3.92×10^{-3}	3.35×10^{-2}
Meat ingestion	2.98×10^{-3}	4.20×10^{-3}
Total	1.83×10^{-2}	5.95×10^{-2}

(a) Source was Exelon (2006a), Table 5.4-11.
(b) Multiply person-Sv/yr times 100 to obtain person-rem/yr.

The staff recognizes the GASPAR II computer program as an appropriate tool for calculating dose to the maximally exposed individual and population from gaseous effluent releases. The staff performed an independent evaluation of gaseous pathway doses and found similar results.

All input parameters used in the Exelon calculations were judged to be appropriate by the staff. Results of the staff's independent evaluation are found in Appendix H.

5.9.3 Impacts to Members of the Public

This section describes the staff's evaluation of the estimated impacts from radiological releases and direct radiation of a new nuclear unit at the Exelon ESP site. The evaluation addresses dose from operations to the maximally exposed individual located at the ESP site and the population dose (collective dose to the population within 80 km [50 mi]) around the ESP site.

5.9.3.1 Maximally Exposed Individual

Exelon (Exelon 2006a) states that total body and organ dose estimates to the maximally exposed individual from liquid and gaseous effluents for a new nuclear unit would be within the design objectives of 10 CFR Part 50, Appendix I. Doses to total body and maximum organ at Clinton Lake from liquid effluents were well within the respective 0.03-mSv/yr (3-mrem/yr) and 0.1-mSv/yr (10-mrem/yr) Appendix I design objectives. Doses at the exclusion area boundary from gaseous effluents were well within the Appendix I design objectives of 0.1 mGy/yr (10 mrad/yr) air dose from gamma radiation, 0.2 mGy/yr (20 mrad/yr) air dose from beta radiation, 0.05 mSv/yr (5 mrem/yr) to the total body, and 0.15 mSv/yr (15 mrem/yr) to the skin.

In addition, dose to the thyroid was within the 0.15 mSv/yr (15 mrem/yr) Appendix I design objective. A comparison of dose estimates for a new nuclear unit to the Appendix I design objectives is found in Table 5-3.

Gaseous and liquid effluents from the CPS contribute a small fraction of the Appendix I design objectives (i.e., less than 1 percent) (AmerGen 2002). Therefore, the cumulative effects of both the current operating unit and a new nuclear unit would be within Appendix I design objectives.

Exelon (Exelon 2006a) states that dose estimates from combined liquid and gaseous effluents to the maximally exposed individual at the site boundary from a new nuclear unit are well within the regulatory standards of 40 CFR Part 190. As stated earlier, exposure at the site boundary from direct radiation sources at a new nuclear unit would be negligible. Table 5-4 compares calculated Exelon doses to the dose standards from 40 CFR Part 190, i.e., 0.25 mSv/yr (25 mrem/yr) to the total body, 0.75 mSv/yr (75 mrem/yr) to the thyroid, and 0.25 mSv/yr (25 mrem/yr) to any other organ.

Table 5-3. Comparison of Maximally Exposed Individual Dose Estimates for a New Nuclear Unit from Liquid and Gaseous Effluents to 10 CFR 50, Appendix I, Design Objectives

Pathway/Type of Dose	Exelon (2006a)[a]	Appendix I Design Objectives[a]
Liquid Effluents		
Total body dose	0.0095 mSv/yr (adult)	0.03 mSv/yr
Maximum organ dose	0.0133 mSv/yr (teen liver)	0.1 mSv/yr
Gaseous Effluents (Noble gases only)		
Gamma air dose	0.0135 mGy/yr	0.1 mGy/yr
Beta air dose	0.0289 mGy/yr	0.2 mGy/yr
Total body dose	0.00875 mSv/yr	0.05 mSv/yr
Skin dose	0.0294 mSv/yr	0.15 mSv/yr
Gaseous effluents (Radioiodines and particulates)		
Organ dose	0.0944 mSv/yr (thyroid)	0.15 mSv/yr

(a) Multiply mSv/yr or mGy/yr times 100 to obtain mrem/yr or mrad/yr.

Table 5-4. Comparison of Maximally Exposed Individual Dose Estimates from Liquid and Gaseous Effluents to 40 CFR Part 190 Standards

Dose	Exelon (2006a) Estimate (mSv/yr)[(a)(b)]	40 CFR Part 190 Standards (mSv/yr)[(b)]
Whole body dose equivalent	0.0321	0.25
Thyroid dose	0.0947	0.75
Dose to another organ	0.0133 (teen liver) - liquid 0.0371 (bone) - gaseous	0.25

(a) Sum of dose from liquid and gaseous effluent releases.
(b) Multiply mSv/yr times 100 to obtain mrem/yr.

Doses to the maximally exposed individual from the CPS are smaller than the dose estimates for a new nuclear unit. Section 2.5 states that the maximum annual dose to a member of the public from gaseous and liquid effluents at the CPS is typically less than 3×10^{-5} mSv (less than 0.003 mrem). Section 4.9 states that direct radiation exposures from the CPS do not vary significantly from background radiation levels at the site boundary. Therefore, the combined dose to the maximally exposed individual from the CPS and a new nuclear unit would be well within the 40 CFR Part 190 standards, 10 CFR Part 20 standards, and 10 CFR Part 50, Appendix I, design objectives.

5.9.3.2 Population Dose

Exelon estimates the collective total body dose within an 80-km (50-mi) radius of the Exelon ESP site to be 0.0183 person Sv/yr (1.83 person-rem/yr) (Exelon 2006a). The estimated collective dose to the same population from natural background radiation is estimated to be 2300 person-Sv/yr (230,000 person-rem/yr) (Exelon 2006a). The dose from natural background radiation was calculated by multiplying the projected 80-km (50-mi) population data for 2010 of approximately 800,000 people by the annual background dose rate of 2.85 mSv/yr (285 mrem/yr) (Exelon 2006a).

Collective dose was estimated using the GASPAR II computer code and was attributed to the gaseous effluent pathway. Collective dose from the liquid effluent pathway was not calculated since Clinton Lake and Salt Creek are not a source of public drinking water or irrigation water, and no commercial fishing is allowed (Exelon 2006a). The staff performed an independent evaluation of population doses and found similar results (see Appendix H).

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures.

Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), BEIR VII report, supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably over estimates those risks.

Based on this model, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from International Commission on Radiation Protection (ICRP) Publication 60 (ICRP 1991). This coefficient was multiplied by the estimated collective whole body population dose of 0.0183 person-Sv/yr (1.83 person-rem/yr) to calculate that the population living within 80 km (50 mi) of the Exelon ESP site would incur a total of approximately 0.0013 fatal cancers, nonfatal cancers, and severe hereditary effects annually. The risks from the cumulative radiation exposure from the CPS and the proposed ESP plant would be only slightly higher. This risk is very small compared to the estimated 170 fatal cancers, nonfatal cancers, and severe hereditary effects that the same population would incur annually from exposure to natural sources of radiation.

In addition, at the request of the U.S. Congress, the NCI conducted a study and published, "Cancer in Populations Living Near Nuclear Facilities," in 1990 (NCI 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (NCI 1990).

5.9.3.3 Summary of Radiological Impacts to Members of the Public

The staff evaluated the health impacts from routine gaseous and liquid radiological effluent releases from a new nuclear unit at the Exelon ESP site. Based on the information provided by Exelon and on its own independent evaluation, the staff concludes there would be no observable health impacts to the public from normal operation of a new nuclear unit, and the health impacts would be SMALL.

5.9.4 Occupational Doses to Workers

Limited information was available on occupational dose estimates from the advanced reactor designs. Dominion and Bechtel (2002) reported annual occupational dose estimates of 1.5 person-Sv (150 person-rem) for the advanced pressurized water reactor (AP1000), the International Reactor Innovative and Secure (IRIS), and gas turbine modular helium reactor designs. On the basis of information contained in NUREG-0713 (NRC 2002b) the average annual collective dose per operating reactor in the United States was 1.72 person-Sv/yr (172 person-rem/yr) for the time period of 1992-2001. The estimated occupational doses for the advanced reactor designs were slightly less than the annual occupational doses for current light water reactors (LWRs).

Exelon (2006a) concluded that occupational exposures for the new nuclear unit would likely be bounded by occupational exposures from currently operating LWRs based on the following: (1) advanced LWR designs have or will incorporate radiation protection features that are improved over the designs provided in currently operating LWRs and (2) gas-cooled reactor design-basis source terms and expected operating characteristics exhibit lower radiation levels during normal operation and for abnormal operating occurrences than currently operating LWRs.

The licensee of a new plant will need to maintain individual doses to workers within 0.05 Sv (5 rem) annually as specified in 10 CFR 20.1201 and apply the ALARA process to maintain doses below this limit.

The staff concludes that the health impacts from occupational radiation exposure would be SMALL based on individual worker doses being maintained within 10 CFR 20.1201 limits and collective occupational doses being typical of doses found in current operating LWR reactors.

5.9.5 Impacts to Biota Other than Members of the Public

Exelon estimated doses to surrogate biota species, including fish, invertebrates, algae, muskrat, raccoon, heron, and duck. Fish, invertebrates, and algae are referred to as aquatic species. Muskrats, raccoons, herons, and ducks are referred to as terrestrial species. Important biota species for the Exelon ESP site and the corresponding surrogate species are as follows: (1) spike (freshwater mussel) - invertebrate, (2) channel catfish, hybrid striped bass, largemouth bass, and walleye - fish, (3) whitetail deer, turkey, rabbit, squirrel, and raccoon - raccoon and muskrat, (4) duck, teal, coot, and Canada goose - duck, and (5) sandpiper and heron - heron (Exelon 2006a). Surrogate species are well-defined and provide an acceptable method for judging doses to the biota. Exposure pathways considered in evaluating dose to the biota were discussed in Section 5.9.1 and shown in Figure 5-2.

5.9.5.1 Liquid Effluent Pathway

Exelon (2006a) used the LADTAP II computer code to calculate doses to the biota from the liquid effluent pathway. In estimating the concentration of radioactive effluents in Clinton Lake, Exelon (2006a) used a partially mixed impoundment model. Liquid pathway doses were higher for biota compared to man because of considerations for bioaccumulation of radionuclides, ingestion of aquatic plants, ingestion of invertebrates, and increased time spent in water and shoreline compared to man. The liquid effluent releases used in estimating biota dose are found in Table 3.5-1 of the ER (Exelon 2006a). Input parameters into the LADTAP II computer code assumed no credit for dilution or transit time from the outflow. Parameters for surrogate species are found in Tables 5.4-15, 5.4-16, and 5.4-17 of the ER (Exelon 2006a) and were taken from Strenge et al. (1986) and NRC (1977). These parameters include food intake, body mass, effective body radius, shoreline exposure, and swimming exposure. Total body dose estimates to the surrogate species from the liquid pathway are shown in Table 5-5.

5.9.5.2 Gaseous Effluent Pathway

Gaseous effluents would contribute to the total body dose of the terrestrial surrogate species (i.e., muskrat, raccoon, heron, and duck). The exposure pathways include inhalation of airborne radionuclides, external exposure due to immersion in gaseous effluent plumes, and surface exposure from deposition of iodine and particulates from gaseous effluents. The dose calculated to the maximally exposed individual from gaseous effluent releases in Table 5-1 would also be applicable to terrestrial surrogate species with one modification. The one modification defined in Exelon (2006a) was increasing the ground deposition factors by a factor of two as terrestrial animals would be closer to the ground than the maximally exposed individual. The gaseous effluent releases used in estimating dose are found in Table 3.5-3 of the ER (Exelon 2006a). The ER used doses at the exclusion area boundary (1.03 km [0.64 mi]) NNE of the ESP site) in estimating terrestrial species doses. Total body dose estimates to the surrogate species from the gaseous pathway are shown in Table 5-5.

Table 5-5. Comparison of Biota Doses from the Exelon ESP Site to 40 CFR Part 190[(a)]

Biota	Liquid Effluents - Internal Dose (mGy/yr)[(b)]	Liquid Effluents - External Dose (mGy/yr)[(b)]	Gaseous Effluents - Internal Dose (mGy/yr)[(b)]	Gaseous Effluents - External Dose (mGy/yr)[(b)]	Total Body Biota Dose All Pathways (mGy/yr)[(b)]	40 CFR Part 190 Total Body Dose Limit (mSv/yr)[(a)]
Fish	2.43×10^{-2}	3.82×10^{-2}	-	-	6.25×10^{-2}	2.5×10^{-1}
Invertebrate	6.11×10^{-2}	7.63×10^{-2}	-	-	1.37×10^{-1}	2.5×10^{-1}
Algae	2.78×10^{-1}	7.18×10^{-5}	-	-	2.78×10^{-1}	2.5×10^{-1}
Muskrat	1.34×10^{-1}	2.55×10^{-2}	1.66×10^{-3}	1.06×10^{-2}	1.72×10^{-1}	2.5×10^{-1}
Raccoon	4.57×10^{-2}	1.91×10^{-2}	1.66×10^{-3}	1.44×10^{-2}	8.09×10^{-2}	2.5×10^{-1}
Heron	6.63×10^{-1}	2.55×10^{-2}	8.3×10^{-4}	6.27×10^{-3}	6.96×10^{-1}	2.5×10^{-1}
Duck	1.2×10^{-1}	3.82×10^{-2}	1.66×10^{-3}	1.16×10^{-2}	1.72×10^{-1}	2.5×10^{-1}

(a) Data taken from Table 5.4-18 of Exelon (2006a).
(b) Multiply mGy/yr or mSv/yr times 100 to obtain mrad/yr or mrem/yr.

5.9.5.3 Impact of Estimated Biota Doses

Table 5-5 also compares the annual total body dose estimates to surrogate biota species from a new nuclear unit to the annual whole body dose standard in 40 CFR Part 190. Although the 40 CFR Part 190 standards apply to members of the public in unrestricted areas and not to biota, they are provided here for comparative purposes. Dose estimates to the biota from the CPS would not be significant when compared to those of a new nuclear unit because the current operating plant has not had any liquid effluent releases in the past 9 years. Radiation doses to the biota are expressed in units of absorbed dose (mGy [mrad]) because dose equivalent (mSv [mrem]) only applies to human radiation doses. Exelon assumed that mSv (mrem) and mGy (mrad) are approximately equivalent for comparison of biota doses to the 40 CFR Part 190 standards. Annual dose to algae and heron-surrogate species exceeded the dose standard in 40 CFR Part 190. The biota dose estimates of a new nuclear unit are conservative because they do not consider dilution or decay of liquid effluents during transit. Actual doses to the biota are likely to be much less.

The International Commission on Radiation Protection (ICRP 1977; ICRP 1991) states that if humans are adequately protected, other living things are also likely to be sufficiently protected. The International Atomic Energy Agency (IAEA 1992) and the National Council on Radiation Protection and Measurements (NCRP 1991) reported that a chronic dose rate of no greater than 10 mGy/d (1000 mrad/d) to the maximally exposed individual in a population of aquatic organisms would ensure protection of the population. IAEA (1992) also concluded that chronic dose rates of 1 mGy/d (100 mrad/d) or less do not appear to cause observable changes in terrestrial animal populations. Table 5-6 compares the estimated total body dose to the biota from a new nuclear unit to the IAEA chronic dose rate values for aquatic organisms and terrestrial animals. The cumulative effects of the CPS and a new nuclear unit result in dose rates less than those of the NCRP and IAEA studies.

The staff performed an independent evaluation of doses to biota and found similar results. Results of the staff's independent evaluation are found in Appendix H.

Based on the information provided by Exelon and its own independent evaluation, the staff concludes that the radiological impact on biota from the routine operation of a new nuclear unit at the proposed ESP site would be SMALL, and mitigation would not be warranted.

5.9.6 Radiological Monitoring

Exelon would establish a radiological environmental monitoring program (REMP) for the Exelon ESP site to monitor the radiological environment around the site during pre-construction and construction phases and during operation of a new nuclear unit (Exelon 2006a). The purpose

Table 5-6. Comparison of Biota Doses from a New Nuclear Unit at the Exelon ESP Site to Relevant Guidelines for Biota Protection[(a)]

Biota	Total Body Dose - Exelon ESP Unit (mGy/d)[(b)]	IAEA/NCRP Guidelines for Protection of Biota Populations (mGy/d)[(b)]
Fish	1.71×10^{-4}	10
Invertebrate	3.76×10^{-4}	10
Algae	7.62×10^{-4}	10
Muskrat	4.71×10^{-4}	1
Raccoon	2.22×10^{-4}	1
Heron	1.91×10^{-3}	1
Duck	4.70×10^{-4}	1

(a) Total dose from liquid and gaseous effluents in Table 5-5.
(b) Multiply mGy/d times 100 to obtain mrad/d.
IAEA = International Atomic Energy Agency.
NCRP = National Council on Radiation Protection and Measurements.

of the REMP is to sample, measure, analyze, and monitor the radiological impact of proposed reactor operations on the environment.

The program would be implemented in accordance with 10 CFR 20.1501 and 10 CFR Part 50, Appendix A, General Design Criterion 64. The program would consist of two phases: pre-operational and operational. The pre-operational program would evaluate radiation exposure rates and concentrations in the environment that contribute to construction worker dose. The pre-operational program would be developed from baseline data already established for the CPS (Exelon 2006a). The operational and pre-operational phases would be essentially the same. To the greatest extent practical, the REMP for the ESP program would utilize the sampling locations used by the CPS. Additional sampling locations might be added as necessary.

The REMP would include the following six environmental elements: direct radiation, atmosphere, aquatic, terrestrial environments, groundwater, and surface water. Analyses performed on environmental samples collected would include gross alpha and beta analysis, gamma spectroscopy analysis, tritium analysis, strontium analysis, and gamma dose (using thermoluminescent dosimetry only).

In an annual Radiological Environmental Operating Report (e.g., AmerGen 2002) for the entire site, including both the CPS and a new nuclear unit, data will be compared with those for previous years. In addition, an inter-laboratory comparison program currently exists and an independent laboratory will continue to verify the program results. A quality assurance program will be implemented for the program. The staff reviewed Exelon's proposed REMP and finds it adequate.

5.10 Environmental Impacts of Postulated Accidents

The staff considered the radiological consequences on the environment of potential accidents at a new nuclear unit at the Exelon ESP site. Consequence estimates are based on the General Electric advanced boiling water reactor (ABWR) standard reactor design, which has been certified by the NRC, and the surrogate Westinghouse AP1000. The term "accident," as used in this section, refers to any off-normal event not addressed in Section 5.9 that results in release of radioactive materials into the environment. The focus of this review is on events that could lead to releases substantially in excess of permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Numerous features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which comprise the first line of defense, are intended to prevent the release of radioactive materials from the plant. The design objectives and the measures for keeping levels of radioactive materials in effluents to unrestricted areas is as low as reasonable achievable are specified in 10 CFR Part 50, Appendix I. There are additional measures that are designed to mitigate the consequences of failures in the first line of defense. These include the NRC's reactor site criteria in 10 CFR Part 100, which require the site to have certain characteristics that reduce the risk to the public and the potential impacts of an accident, and emergency preparedness plans and protective action measures for the site and environs, as set forth in 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0654/FEMA-REP-1 (NRC 1980). All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

This section discusses (1) the types of radioactive materials, (2) the paths to the environment, (3) the relationship between radiation dose and health effects, and (4) the environmental impacts of reactor accidents, both design basis accidents (DBAs) and severe accidents. The environmental impacts of accidents during transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive materials in the environment depends on the mechanical forces that physically transport the materials and on the physical and chemical forms of the material. Radioactive material exists in a variety of physical and chemical forms. The majority of the material in the fuel is in the form of nonvolatile solids. However, there is a significant amount of material that is in the form of volatile solids or gases. The gaseous radioactive materials include the chemically inert noble gases (e.g., krypton and xenon), which have a high potential for release. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and, therefore, have a lower tendency to escape from the fuel than the noble gases and iodines.

Radiation exposure to individuals is determined by their proximity to radioactive material, the duration of their exposure, and the extent to which they are shielded from the radiation. Pathways that lead to radiation exposure include (1) external radiation from radioactive material in the air, on the ground, and in the water, (2) inhalation of radioactive material, and (3) ingestion of food or water containing material initially deposited on the ground and in water.

The risks of health effects from radiation exposure are either too small to be observed or are nonexistent below 0.1 Sv (10 rem) (HPS 2004). Incidence of cancer in the exposed general population may begin to develop after a lapse of 2 to 15 years (latent period) after exposure and then level off over a period of about 30 years (plateau period). In the case of radiation exposure of fetuses, cancer may begin to develop as early as at birth (no latent period) to the age of 10.

Physiological effects are clinically detectable should individuals receive radiation exposure resulting in a dose greater than about 0.25 Sv (25 rem) over a short period of time (hours). Doses of about 2.5 to 5.0 Sv (250 to 500 rem) received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.10.1 Design Basis Accidents

Exelon evaluated the potential consequences of postulated accidents to demonstrate that a new nuclear unit could be constructed and operated at the Exelon ESP site without undue risk to the health and safety of the public. These evaluations used a set of surrogate DBAs that are representative of the range of reactor designs being considered for the ESP site and site-specific meteorological data. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The DBA review focuses on two LWR designs: the ABWR and the surrogate AP1000. The bases for analyses of postulated accidents for these designs are well established because they have been considered as part of the NRC's advanced reactor design certification process. Accidents for the other reactor designs listed in the application are not as well defined as those for the ABWR and AP1000; acceptable assumptions and methodologies for the evaluation of postulated accidents have not been fully established. Because the source terms for accident analyses are generically proportional to the power level, for the purpose of this site-suitability evaluation, the potential consequences of accidents for the other reactor designs are expected to be bounded by those for the ABWR and the surrogate AP1000 designs. For example, preliminary information on source terms for the IRIS and ACR-700 reactor designs indicates that the source terms for the surrogate AP1000 loss-of-coolant accident (LOCA) will bound the worst case accident releases for these advanced reactor designs. Similarly, the ABWR source term will bound the source term for the Economic Simplified Boiling Water Reactor (ESBWR) design. The advanced gas reactor designs (Gas Turbine-Modular Helium Reactor [GT-MHR] and pebble bed modular reactor [PBMR]) postulate relatively small releases to the environment compared to water reactor technologies (Exelon 2006a).

Should an application that references an ESP at the Exelon site be made to build and operate one of the designs other than the ABWR or surrogate AP1000, Exelon would be required to show - and the staff would verify - that the radiological consequences of DBAs for the proposed reactor(s) are bounded by the consequences of DBAs evaluated in this EIS.

Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the amount of each radionuclide released, and the meteorological conditions. The source terms for the ABWR reactor design are based on TID-14844 (AEC 1962) guidance, and guidance on methods for evaluating potential accidents for the ABWR are set forth in NUREG-0800 (NRC 1987), Regulatory Guide 1.3 (NRC 1974a), and Regulatory Guide 1.25 (NRC 1974b). The source terms for the surrogate AP1000 reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000a).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as χ/Q. Acceptable methods of calculating χ/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983).

Table 5-7 lists χ/Q values pertinent to the evaluation of the suitability of the Exelon ESP site. The first column lists the time periods and boundaries for which χ/Q and dose estimates are needed. For the exclusion area boundary, the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term, i.e., 2 hours, and for the low population zone, they are calculated for the course of the accident, i.e., 30 days (720 hours) composed of four time periods. The second column lists the χ/Q values presented in Exelon's ER Section 2.7.6 using the site meteorological information discussed in ER Section 2.7.4 and the exclusion area boundary and low population zone distances (Exelon 2006a). No credit was taken for building wake.

Exelon calculated the χ/Q values listed in Table 5-7 (1) using a set of meteorological data for the ESP site that covered 32 months, and (2) assuming the release point was located at the center of the proposed ESP facility footprint. The staff evaluated possible changes in the χ/Q values (1) based on 36 months (2000 - 2002) of meteorological data, and (2) assuming that the release point would be 220 m (722 ft) closer to the exclusion area boundary and low population zone in each downwind sector. These changes in the χ/Q values were small and would not significantly change the calculated doses.

Small χ/Q values are associated with greater dilution capability. Thus, if the design χ/Q values for a specific reactor design identified as part of a CP or COL application are greater than or equal to the site χ/Q values, atmospheric dispersion at the site is sufficient such that the doses predicted for postulated DBAs for the design will be below regulatory limits if the source terms are bounded by the PPE.

The staff concludes that the atmospheric dispersion characteristics of the Exelon ESP site are acceptable with respect to the potential environmental consequences of postulated DBAs for reactor designs with design χ/Q values falling within the bounds set by the site χ/Q values. At the CP or COL stage, the applicant would need to demonstrate that the χ/Q values used in analyzing the reactor design proposed at the CP or COL stage are equal to or greater than the site χ/Q values specified in the ESP. Additional evaluation will be needed if reactor design χ/Q values do not meet this criterion.

Tables 5-8 and 5-9 list the set of surrogate DBAs considered by Exelon and present its estimate of the environmental consequences of each accident in terms of total effective dose equivalent (TEDE). TEDE is the sum of the committed effective dose equivalent from inhalation and the deep dose equivalent from external exposure. Dose conversion factors from Federal Guidance

Table 5-7. Atmospheric Dispersion Factors for Exelon ESP Site Design Basis Accident Calculations

Time Period and Boundary	χ/Q (s/m^3)
0 to 2 hr, Exclusion Area Boundary	3.56×10^{-5}
0 to 8 hr, Low Population Zone	3.40×10^{-6}
8 to 24 hr, Low Population Zone	2.85×10^{-6}
1 to 4 d, Low Population Zone	1.85×10^{-6}
4 to 30 d, Low Population Zone	1.00×10^{-6}

Table 5-8. Design Basis Accident Doses for an ABWR

Accident	Standard Review Plan Section[(b)]	TEDE (Sv)[(a)] Exclusion Area Boundary	Low Population Zone	Review Criterion
Main steam line break	15.6.4			
Pre-existing iodine spike		6.8×10^{-4}	6.5×10^{-5}	2.5×10^{-1} (c)
Accident-initiated iodine spike		3.4×10^{-5}	3.3×10^{-6}	2.5×10^{-2} (d)
Loss-of-coolant accident	15.6.5	2.3×10^{-3}	7.6×10^{-3}	2.5×10^{-1} (c)
Failure of small lines carrying primary coolant outside containment	15.6.2	3.0×10^{-5}	5.7×10^{-6}	2.5×10^{-2} (d)
Fuel handling	15.7.4	8.0×10^{-4}	9.8×10^{-5}	6.25×10^{-2} (d)

(a) To convert Sv to rem, multiply by 100.
(b) NUREG-0800 (NRC 1987).
(c) 10 CFR 50.34(a)(1) and 10 CFR 100.11 criteria.
(d) Standard Review Plan criterion.

Table 5-9. Design Basis Accident Doses for an AP1000 Reactor

Accident	Standard Review Plan Section[(b)]	TEDE in Sv[(a)] EAB[(c)]	LPZ[(d)]	Review Criterion
Main steam line break	15.1.5			
Pre-existing iodine spike		4.2×10^{-4}	1.3×10^{-4}	2.5×10^{-1}(e)
Accident-initiated iodine spike		4.7×10^{-4}	5.0×10^{-4}	2.5×10^{-2}(f)
Steam generator rupture	15.6.3			
Pre-existing iodine spike		1.8×10^{-3}	8.8×10^{-5}	2.5×10^{-1}(e)
Accident-initiated iodine spike		8.9×10^{-4}	6.6×10^{-5}	2.5×10^{-2}(f)
Loss-of-coolant accident	15.6.5	1.5×10^{-2}	2.6×10^{-3}	2.5×10^{-1}(e)
Rod ejection	15.4.8	1.8×10^{-3}	4.5×10^{-4}	6.25×10^{-2}(f)
Reactor coolant pump rotor seizure (locked rotor)	15.3.3	1.5×10^{-3}	1.5×10^{-4}	2.5×10^{-2}(f)
Failure of small lines carrying primary coolant outside containment	15.6.2	7.7×10^{-4}	7.6×10^{-5}	2.5×10^{-2}(f)
Fuel handling	15.7.4	1.4×10^{-3}	1.5×10^{-4}	6.25×10^{-2}(f)

(a) To convert Sv to rem, multiply by 100.
(b) NUREG-0800 (NRC 1987).
(c) Exclusion area boundary.
(d) Low population zone.
(e) 10 CFR 50.34(a)(1) and 10 CFR 100.21 criteria.
(f) Standard Review Plan criterion.

Report 11 (Eckerman et al. 1988) were used to calculate the committed effective dose equivalent. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the deep dose equivalent. Equivalent TEDE values were estimated for the ABWR by multiplying the thyroid dose by a factor 0.03 (the organ weighing factor for the thyroid in the TEDE methodology) and adding the product to the whole body dose. The review criteria used in the staff's safety review of DBA doses are included in Tables 5-8 and 5-9 to illustrate how small the calculated environmental consequences (TEDE doses) are.

In addition to the evaluation of consequences of the DBAs for the ABWR and surrogate AP1000 designs described above, Exelon evaluated the consequences of postulated LOCAs for the ESBWR and Advanced Canada Deuterium Uranium Reactor (ACR-700) reactor designs. Table 5-10 lists the estimated TEDE for each design. The review criteria used in the staff's safety review of DBA doses are included in Table 5-10 to illustrate how small the calculated environmental consequences (TEDE doses) are.

In all cases, the calculated TEDE values are considerably smaller than the TEDE doses used as safety review criteria. Therefore, the staff concludes that the Exelon ESP site is suitable for operation of new advanced LWRs. Should an applicant for a CP or COL reference an LWR design, the applicant would need to demonstrate that χ/Q values used in analyzing the reactor design proposed at the CP or COL stage are equal to or greater than the site χ/Q values specified in the ESP. Additional evaluation will be needed if reactor design χ/Q values do not meet this criterion. The environmental impacts of DBAs have not been explicitly evaluated for gas-cooled reactors because necessary design information is lacking. Therefore, the impacts of gas-cooled reactors are unresolved. However, the staff expects that releases to the environment under accident conditions would be small for such designs.

Table 5-10. Potential Consequences of Postulated Loss-of-Coolant Accidents for the ESBWR and ACR-700 Reactor Designs

	TEDE (Sv)[(a)]		
Reactor Design	**Exclusion Area Boundary**	**Low Population Zone**	**Review Criterion[(b)]**
ESBWR	3.1×10^{-3}	4.7×10^{-3}	2.5×10^{-1}
ACR-700	3.8×10^{-3}	4.2×10^{-3}	2.5×10^{-1}

(a) To convert Sv to rem, multiply by 100.
(b) 10 CFR 50.34(a)(1) criterion.

Summary of Design Basis Accident Impacts

Although Exelon chose to use the PPE approach in its ESP application, the applicant based its evaluation of the environmental impacts of DBAs on characteristics of the ABWR and the surrogate AP1000 reactor designs with the explicit assumption that these impacts would bound the impacts of other advanced LWR designs (Exelon 2006a). The NRC staff reviewed the analysis in the ER, which is based on analyses performed for design certification of these reactor designs. The results of the Exelon analyses indicate that the environmental risks associated with DBAs, if an advanced LWR were to be located at the Exelon ESP site, would be small compared to the TEDE doses used as safety review criteria. On this basis, the staff concludes that the consequences of DBAs at the Exelon ESP site are of SMALL significance for advanced LWRs and that the Exelon ESP site is suitable for operation of advanced LWRs. Should an applicant for a CP or COL reference an LWR design, the applicant would need to demonstrate that χ/Q values used in analyzing the reactor design proposed at the CP or COL stage are equal to or greater than the site χ/Q values specified in the ESP. Additional evaluation will be needed if reactor design χ/Q values do not meet this criterion. The environmental impacts of DBAs for gas-cooled reactors have not been explicitly evaluated and are, therefore, unresolved. These impacts would need to be evaluated at the CP or COL stage if such a design were selected.

5.10.2 Severe Accidents

In its ER, Exelon bases its evaluation of the potential environmental consequences of severe accidents on the evaluation of potential consequences of severe accidents for the current-generation reactors presented in NUREG-1437 (NRC 1996). Three pathways were considered: (1) the atmospheric pathway, in which radioactive material is released to the air, (2) the surface water pathway, in which airborne radioactive material falls out on open bodies of water, and (3) the groundwater pathway, in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

In response to an NRC request for additional information, dated May 11, 2004 (NRC 2004a), Exelon performed a site-specific analysis of the potential environmental consequences of postulated severe accidents at the Exelon ESP site. Because the PPE does not include source terms for severe accidents Exelon used the source terms for the ABWR and surrogate AP1000 reactors as PPE values. Exelon used the MACCS2 computer code (Chanin et al. 1990; Jow et al. 1990) for the analysis. Input to the MACCS2 code and summarized results of the analysis were submitted to the NRC in a letter dated July 23, 2004 (Exelon 2004a).

The MACCS computer code was developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). MACCS2 (Chanin and Young 1997) is the current version of MACCS. The MACCS and MACCS2 codes evaluate the consequences of atmospheric releases of material following a severe accident. The pathways modeled include exposure to the passing plume, exposure to material deposited on the ground and skin, inhalation of material in the passing plume and resuspended from the ground, and ingestion of contaminated food and surface water. The primary enhancements in MACCS2 are that MACCS2 has (1) a more flexible emergency-response model, (2) an expanded library of radionuclides, and (3) a semidynamic food-chain model (Chanin and Young 1997).

Three types of severe accident consequences were assessed: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early cancer fatalities and latent fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990). Latent fatalities are related to exposure of a large number of people to low doses and dose rates and can be expected to occur after a latent period of several (2 to 15) years. Population health-risk estimates are based on the population distribution within an 80-km (50-mi) radius of the site. Economic costs of a severe accident include the costs associated with short-term relocation of people; decontamination of property and equipment; interdiction of food supplies, land, and equipment use; and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident. Farm land decontamination is an estimate of the area that has an average whole body dose rate for the 4-year period following the release that would be greater than 0.005 Sv/yr (0.5 rem/yr) if not reduced by decontamination and that would have a dose rate following decontamination of less than 0.005 Sv/yr (0.5 rem/yr). Decontaminated land is not necessarily suitable for farming.

Risk is the product of the frequency and the consequences of an accident. For example, the probability of a severe accident without loss of containment for an ABWR is estimated to be 1.34×10^{-7} per reactor year (Ryr^{-1}), and the cumulative population dose associated with a severe accident without loss of containment at the Exelon ESP site is calculated to be 8.18×10^{1} person-Sv (8.18×10^{3} person-rem). The population dose risk for this class of accidents is the product of 1.34×10^{-7} Ryr^{-1} and 8.18×10^{1} person-Sv, or 1.10×10^{-5} person-Sv Ryr^{-1} (1.10×10^{-3} person-rem Ryr^{-1}). The following sections discuss the estimated risks associated with each pathway.

The risks presented in the tables that follow are risks per year of reactor operation. Exelon has indicated that the ESP site could hold two reactors of the surrogate AP1000 design. The consequences of a severe accident would be the same regardless of whether one or two surrogate AP1000 reactors were built. However, if two of the surrogate AP1000 reactors were built, the risks would apply to each reactor, and the total risk for new reactors at the site would be twice the risk for a single reactor. Even if the risk values were doubled, the risks would still be significantly smaller than the risks associated with current-generation reactors.

Air Pathway. The MACCS2 code directly estimates consequences associated with releases to the air pathway. The results of the MACCS2 runs are presented in Tables 5-11 and 5-12. The core damage frequencies given in these tables are for internally initiated accident sequences while the plant is at power. Internally initiated accident sequences include sequences that are initiated by human error, equipment failures, loss of offsite power, etc. Based on insights from the review of the advanced LWR probabilistic risk assessments, the core damage frequencies for externally initiated events and during shutdown would be comparable to or lower than those for internally initiated events.

Tables 5-11 and 5-12 show that the probabilistically weighted consequences, i.e., risks, of severe accidents for an ABWR or surrogate AP1000 reactor located on the Exelon ESP site are small for all risk categories considered. For perspective, Tables 5-13 and 5-14 compare the health risks from severe accidents for the ABWR and the surrogate AP1000 reactors at the Exelon ESP site with the risks for current-generation reactors at various sites.

In Table 5-13, the health risks estimated for the ABWR and surrogate AP1000 reactors at the Exelon ESP site are compared with health-risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only risks associated with internally initiated events are presented in Table 5-13. The health risks shown for the ABWR and surrogate AP1000 reactors at the Exelon ESP site are significantly lower than the risks associated with current generation reactors presented in NUREG-1150.

In addition, the last two columns of Table 5-13 provide average individual fatality risk estimates for comparison to the Commission's safety goals. The Commission has set safety goals for average individual early fatality and latent cancer fatality risks from reactor accidents in the Safety Goal Policy Statement (NRC 1986). The Policy Statement expressed the Commission's policy regarding the acceptance level of radiological risk from nuclear power plant operation as follows:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Table 5-11. Mean Environmental Risks from ABWR Severe Accidents at the Exelon ESP Site

	Release Category Description (Accident Class)	Environmental Risk						
		Core Damage Frequency (Ryr^{-1})	Population Dose (person-Sv Ryr^{-1})[(a)]	Fatalities (Ryr^{-1})		Cost[(d)] ($ Ryr^{-1})	Farm Land Decontamination[(e)] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[(a)]
				Early[(b)]	Latent[(c)]			
0	No loss of containment	1.34×10^{-7}	1.10×10^{-5}	0	4.76×10^{-7}	3.58×10^{-1}	2.71×10^{-6}	1.20×10^{-8}
1	Transients followed by failure of high-pressure coolant makeup and failure to depressurize in timely fashion	2.08×10^{-8}	1.59×10^{-6}	0	7.88×10^{-8}	6.45×10^{-2}	2.58×10^{-7}	2.08×10^{-9}
2	Short-term station blackout with reactor core isolation cooling (RCIC) failure, onsite power recovery in 8 hr	1.00×10^{-10}	3.80×10^{-9}	0	1.63×10^{-10}	3.82×10^{-5}	1.71×10^{-11}	1.93×10^{-12}
3	Station blackout with RCIC available for about 8 hr	1.00×10^{-10}	2.33×10^{-7}	0	1.08×10^{-8}	2.07×10^{-2}	5.05×10^{-7}	8.55×10^{-10}
4	Station blackout (more than 8 hr) with RCIC failure	1.00×10^{-10}	1.52×10^{-7}	0	6.77×10^{-9}	1.36×10^{-2}	3.54×10^{-7}	6.19×10^{-10}
5	Transients followed by failure of high-pressure coolant makeup, successful depressurization of reactor, failure of low-pressure coolant makeup	1.00×10^{-10}	6.32×10^{-8}	0	2.43×10^{-9}	1.32×10^{-2}	1.50×10^{-7}	2.05×10^{-10}
6	Transient, loss-of-coolant accident (LOCA), and anticipated transient without scram (ATWS) events with successful coolant makeup, but potential prior failure of containment	1.00×10^{-10}	7.81×10^{-7}	6.83×10^{-15}	3.51×10^{-8}	6.53×10^{-1}	1.35×10^{-5}	3.00×10^{-8}
7	Small/medium LOCA followed by failure of high-pressure coolant makeup and failure to depressurize	3.91×10^{-10}	3.24×10^{-6}	2.33×10^{-12}	1.43×10^{-7}	$2.98 \times 10^{+0}$	5.98×10^{-5}	1.51×10^{-7}
8	LOCA followed by failure of high-pressure coolant makeup	4.05×10^{-10}	4.21×10^{-6}	6.64×10^{-10}	1.84×10^{-7}	$4.78 \times 10^{+0}$	8.46×10^{-5}	3.50×10^{-7}

Table 5-11. (contd)

Release Category Description (Accident Class)	Core Damage Frequency (Ryr^{-1})	Environmental Risk					
		Population Dose (person- Sv Ryr^{-1})[(a)]	Fatalities (Ryr^{-1})		Cost[(d)] (\$ Ryr^{-1})	Farm Land Decontamination[(e)] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[(a)]
			Early[(b)]	Latent[(c)]			
9 ATWS followed by boron injection failure and successful high-pressure coolant makeup	1.70×10^{-10}	2.28×10^{-6}	1.26×10^{-10}	1.08×10^{-7}	$2.24 \times 10^{+0}$	3.74×10^{-5}	2.50×10^{-7}
Total	1.56×10^{-7}	2.35×10^{-5}	7.93×10^{-10}	1.04×10^{-6}	$1.11 \times 10^{+1}$	1.99×10^{-4}	7.97×10^{-7}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that can be expected to occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is area where the average whole body dose rate for the 4-year period following the accident exceeds 0.005 Sv/yr (0.5 rem/yr) but can be reduced to less than 0.005 Sv/yr (0.5 rem/yr) by decontamination. To convert hectares (ha) to acres, multiply by 2.47.

Table 5-12. Mean Environmental Risks from Surrogate AP1000 Severe Accidents at the Exelon ESP Site

		Environmental Risk						
				Fatalities (Ryr^{-1})				
	Release Category Description (Accident Class)	Core Damage Frequency (Ryr^{-1})	Population Dose (person-Sv Ryr^{-1})[a]	Early[b]	Latent[c]	Cost[d] ($ Ryr^{-1})	Farm Land Decontamination[e] (ha Ryr^{-1})	Population Dose from Water Ingestion (person Sv Ryr^{-1})[a]
CFI	Intermediate containment failure, after core relocation but before 24 hr	1.89×10^{-10}	1.22×10^{-6}	5.76×10^{-11}	6.52×10^{-8}	4.54×10^{-1}	3.70×10^{-6}	3.31×10^{-8}
CFE	Early containment failure, after onset of core damage but before core relocation	7.47×10^{-9}	5.59×10^{-5}	3.10×10^{-9}	2.69×10^{-6}	$4.16 \times 10^{+1}$	8.74×10^{-4}	2.05×10^{-8}
IC	Intact containment	2.21×10^{-7}	1.24×10^{-5}	$0.00 \times 10^{+0}$	6.03×10^{-7}	5.81×10^{-1}	3.89×10^{-6}	2.94×10^{-8}
BP	Containment bypass, fission products released directly to environment	1.05×10^{-8}	1.43×10^{-4}	1.03×10^{-8}	7.76×10^{-6}	$1.45 \times 10^{+2}$	2.65×10^{-3}	1.31×10^{-5}
CI	Containment isolation failure occurs prior to onset of core damage	1.33×10^{-9}	9.23×10^{-6}	4.40×10^{-11}	5.11×10^{-7}	$6.08 \times 10^{+0}$	1.08×10^{-4}	3.19×10^{-7}
CFL	Late containment failure occurring after 24 hr	3.45×10^{-13}	9.97×10^{-10}	6.66×10^{-14}	5.80×10^{-11}	1.07×10^{-3}	8.59×10^{-9}	7.56×10^{-12}
Total		2.40×10^{-7}	2.21×10^{-4}	1.35×10^{-8}	1.16×10^{-5}	$1.94 \times 10^{+2}$	3.64×10^{-3}	1.35×10^{-5}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that can be expected to occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is area where the average whole body dose rate for the 4-year period following the accident exceeds 0.005 Sv/yr (0.5 rem/yr) but can be reduced to less than 0.005 Sv/yr (0.5 rem/yr) by decontamination.

Table 5-13. Comparison of Environmental Risks for an ABWR or a Surrogate AP1000 at the Exelon ESP Site with Risks for Five Sites Evaluated in NUREG-1150[(a)]

	Core Damage Frequency (Ryr^{-1})	50-mi (80-km) Population Dose Risk (person-Sv Ryr^{-1})[(b)]	Fatalities Ryr^{-1}		Average Individual Fatality Risk Ryr^{-1}	
			Early	**Latent**	**Early**	**Latent Cancer**
Grand Gulf[(c)]	4.0×10^{-6}	5×10^{-1}	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[(c)]	4.5×10^{-6}	$7 \times 10^{+0}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[(c)]	5.7×10^{-5}	$1 \times 10^{+1}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[(c)]	4.0×10^{-5}	$5 \times 10^{+0}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[(c)]	3.4×10^{-4}	$5 \times 10^{+1}$	4×10^{-5}	2×10^{-2}	9×10^{-9}	1×10^{-8}
ABWR[(d)]	1.6×10^{-7}	2.4×10^{-5}	7.9×10^{-10}	1.0×10^{-6}	3.8×10^{-14}	3.9×10^{-12}
AP1000[(d)]	2.4×10^{-7}	2.2×10^{-4}	1.4×10^{-8}	1.2×10^{-5}	6.4×10^{-13}	5.5×10^{-11}

(a) NRC 1990
(b) To convert person-Sv to person-rem, multiply by 100.
(c) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
(d) Calculated with MACCS2 code using Exelon ESP site-specific input.

Table 5-14. Comparison of Environmental Risks from Severe Accidents Initiated by Internal Events for an ABWR or a Surrogate AP1000 at the Exelon ESP Site with Risks Initiated by Internal Events for Plants Undergoing Operating License Renewal Review

	Core Damage Frequency (yr^{-1})	80-Km (50-mi) Population Dose Risk (person-Sv Ryr^{-1})[(a)]
Current Reactor Maximum[(b)]	2.4×10^{-4}	6.9×10^{-1}
Current Reactor Mean[(b)]	3.6×10^{-5}	15×10^{-1}
Current Reactor Median[(b)]	2.8×10^{-5}	1.1×10^{-1}
Current Reactor Minimum[(b)]	1.9×10^{-6}	5.5×10^{-3}
ABWR[(c)]	1.6×10^{-7}	2.4×10^{-5}
AP1000[(c)]	2.4×10^{-7}	2.2×10^{-4}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Based on MACCS and MACCS2 calculations for current plants undergoing operating license renewal.
(c) Calculated with MACCS2 code using Exelon ESP site-specific input.

The following quantitative health objectives are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These quantitative health objectives are translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all “other accidents to which members of the U.S. population are generally exposed,” such as fatal automobile accidents, is about 5×10^{-4} per year. One-tenth of one percent of this figure implies that the individual risk of prompt fatality from a reactor accident should be less than 5×10^{-7} per reactor year.

- “The sum of cancer fatality risks resulting from all other causes” for an individual is taken to be the cancer fatality rate in the U.S. which is about 1 in 500 or 2×10^{-3} per year.

> One-tenth of 1 percent of this implies that the risk of cancer to the population in the area near a nuclear power plant because of its operation should be limited to 2 x 10^{-6} per reactor year.

MACCS2 calculates average individual early and latent cancer fatality risks. The average individual early fatality risk is calculated using the population distribution within 1.6 km (1 mi) of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 16 km (10 mi) of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission's safety goals. Risks calculated for the ABWR and the surrogate AP1000 designs at the Exelon ESP site are lower than the risks associated with the current generation reactors considered in NUREG-1150 and are well below the Commission's safety goals.

The staff compared the core damage frequencies and population dose risk estimates for the ABWR and surrogate AP1000 reactors at the Exelon ESP site with statistics summarizing the results of contemporary severe accident analyses performed for 28 current generation operating reactors at 23 sites. The results of these analyses are included in the final site-specific Supplements 1 through 20 to the GEIS for License Renewal, NUREG-1437 (NRC 1996), and in the ERs included with license renewal applications for those plants for which supplements have not been published. All of the analyses were completed after publication of NUREG-1150 (NRC 1990), and 23 of the analyses used MACCS2, which was released in 1997. Table 5-14 shows that the core damage frequencies estimated for the ABWR and surrogate AP1000 reactors are significantly lower than those of current-generation reactors. Similarly, the population doses estimated for the advanced reactors at the Exelon ESP site are well below the mean and median values for current-generation reactors undergoing license renewal.

The staff compared the risk estimates given in Tables 5-11 and 5-12, the comparisons of air pathway risks in Tables 5-13 and 5-14, and the comparison of average individual early fatality and average individual latent cancer fatality risks in Table 5-13 with the Commission's safety goals. Preliminary information on the IRIS and the ACR-700 reactor designs indicates that the surrogate AP1000 will likely bound the risk for these advanced reactor designs. Similarly, the ESBWR risk is expected to be bounded by the risk for the ABWR. On this basis, the staff concludes that the Exelon ESP site is suitable for operation of advanced LWRs.

If, as stated in the ER, the releases from the gas-cooled reactor designs are bounded by the releases from the advanced LWR designs, the site would be suitable for these gas-cooled reactors. The PPE does not contain specific parameters related to severe accidents for gas-cooled reactors. The consequences of severe accidents have not been explicitly evaluated for gas-cooled reactors and will need to be evaluated at the CP or COL stage. For the evaluation in this EIS to bound the reactor design selected at the CP or COL stage, Exelon and the staff will need to verify that the environmental impacts of the air pathway releases for severe accidents at the Exelon ESP site remain bounded by the environmental impacts from the surrogate designs.

Surface-Water Pathways. Surface-water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water. The surface-water pathways of interest include external radiation from submersion in water and activities near the water, ingestion of water, and ingestion of fish and other aquatic creatures. Of these pathways, the MACCS2 code evaluates only the ingestion of contaminated water. The risks associated with this surface-water pathway calculated for the Exelon ESP site are included in the last columns of Tables 5-11 and 5-12. These dose estimates are extremely conservative because no drinking water is withdrawn from surface waters in the vicinity of the ESP site (Exelon 2006a). For each accident class, the population dose risk from ingestion of water is a small fraction of the dose risk from the air pathway.

Clinton Lake is used for recreational activities including swimming and fishing. Doses from these surface-water pathways are not modeled in MACCS or MACCS2. NUREG-1437 (NRC 1996) considered typical population exposure risk for the aquatic food pathway for plants located on small rivers. For these plants, the population dose from the food pathway was well below the population dose from the air pathway. The CPS site, which is co-located with the ESP site, is classified as being on a small river. Analysis of water-related exposure pathways at the Fermi reactor (NRC 1981) suggests that population exposures from swimming are significantly lower than exposures from the aquatic ingestion pathway.

Exelon owns Clinton Lake, which is the major surface-water body in the vicinity of the Exelon ESP site. Clinton Lake is managed by the IDNR. In the event of a large release of radioactive material, population exposures through the surface-water pathways could be minimized by controlling access to the lake.

After considering the water-ingestion dose estimates, the NUREG-1437 evaluations, and Exelon and the State of Illinois control over Clinton Lake access, the staff concludes that the Exelon ESP site is suitable for operation of an ABWR or a surrogate AP1000 reactor; in a similar fashion to the air pathway, the environmental impacts of the surface-water pathway for other advanced LWRs are expected to be bounded by the ABWR and the surrogate AP1000. The environmental impacts of severe accidents for gas-cooled reactors have not been evaluated. The PPE does not contain specific parameters related to severe accidents for gas-cooled reactors, and the consequences of severe accidents for gas-cooled reactors will need to be evaluated at the CP or COL stage. For this evaluation to bound the reactor design selected at the CP or COL stage, Exelon and the staff will need to verify that the environmental impacts of the surface-water pathway releases for severe accidents at the Exelon ESP site remain bounded by the environmental impacts from the surrogate designs.

Groundwater Pathway. Neither MACCS nor MACCS2 evaluates the environmental risks associated with severe accident releases of radioactive material to groundwater. However, this pathway has been addressed in NUREG-1437 in the context of renewal of licenses for current-generation reactors (NRC 1996). NUREG-1437 assumes a 1×10^{-4} Ryr^{-1} probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination, and the staff concluded that groundwater generally contributes a small fraction of the risk attributable to the atmospheric pathway. Although the staff assumed that the probability of occurrence of a release via the groundwater pathway is significantly larger than a release via the atmospheric pathway for either the ABWR or the surrogate AP1000, the groundwater pathway is more tortuous and affords more time for implementing protective actions and, therefore, results in a lower risk to the public. As a result, the staff concludes that the risks associated with releases to groundwater are sufficiently small that they would not have a significant effect on determination of suitability of the Exelon ESP site.

Summary of Severe Accident Impacts. Although Exelon chose the PPE approach in the overall ESP application, it based its evaluation of the environmental impacts of severe accidents on characteristics of the ABWR and surrogate AP1000 reactor designs with the explicit assumption that these impacts would bound the impacts of other potential designs (Exelon 2006a). The NRC staff has reviewed the analysis in the ER and conducted its own confirmatory analysis using the MACCS2 code. The results of both the Exelon analysis and the NRC analysis indicate that the environmental risks associated with severe accidents if an advanced LWR were to be located at the Exelon ESP site would be small compared to risks associated with operation of current-generation reactors at the Exelon ESP site and other sites. These risks are well below the NRC safety goals. On these bases, the staff concludes that the probability weighted consequences of severe accidents at the Exelon ESP site are of SMALL significance for an advanced LWR and that the Exelon ESP site is suitable for operation of an advanced LWR. The environmental impacts of severe accidents of designs not evaluated in this EIS, including gas-cooled designs, are unresolved because information is lacking. Consequently, these impacts would need to be evaluated at the CP or COL stage.

For this evaluation to bound the reactor design selected at the CP or COL stage, Exelon and the staff would need to verify that the environmental impacts of severe accidents at the Exelon ESP site remain bounded by the environmental impacts from the surrogate designs.

5.10.3 Summary of Postulated Accident Impacts

The staff evaluated the environmental impacts from DBAs and severe accidents using the ABWR and the surrogate AP1000 to characterize the environmental impacts from advanced LWRs. As described previously, preliminary information on the IRIS and the ACR-700 reactor designs indicate that the surrogate AP1000 would likely bound the source term, doses, and probability weighted consequences of design basis and severe accidents. Similarly, the

ESBWR source term, doses, and probability weighted consequences of design basis and severe accidents is expected to be bounded by the ABWR.

Based on the information provided by Exelon and the staff's independent review, the staff concludes that the potential environmental impacts from a postulated accident from the operation of a new nuclear unit would be SMALL. The staff did not explicitly evaluate the design basis or severe accident impacts for gas-cooled reactors because of lack of information. Consequently, the impacts of gas-cooled reactors are unresolved.

5.11 Measures and Controls to Limit Adverse Impacts During Operation

The staff relied on the following general measures and controls in its evaluation of environmental impacts of operation of a new nuclear unit at the Exelon ESP site. These measures and controls include those which would be required by applicable permits and authorizations (Federal, State, and local) listed in Table 1.2-1 of the ER. They also include the feasible measures and controls contained in Section 5.10 of the ER (Exelon 2006a):

- Compliance with the applicable Federal, State, and local laws, ordinances, and regulations that prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emission control, noise control, storm water management, spill response and cleanup, and hazardous material management)

- Compliance with applicable requirements of permits and licenses required for operation (e.g., NPDES and IEPA permits and operating license requirements)

- Compliance with Exelon procedures applicable to environmental control and management.

Some of these permits or approvals include:

- NPDES permit requirements imposed on water discharges from the new units (ER Sections 5.2, 5.3, 5.5)

- IEPA permit limits and regulations for installing and operating air emission sources (See Appendix K)

Exelon specifically identified the following general plans or specific mitigation measures in its ER (Exelon 2006a) on which the staff relied in its evaluation:

- Noise levels will be controlled by engineering designs to operate within OSHA's noise exposure limit to workers (29 CFR 1910); Federal noise pollution control regulations (24 CFR 51); and State or local noise pollution control regulations, as applicable (35 IAC Subtitle H). (ER Section 5.10.3.1)

- Care will be taken to control undesirable dust and exhaust emissions. Applicable air-pollution control regulations will be followed. Permits and operating certificates will be secured where required. (ER Section 5.10.3.2)

- Erosion and sedimentation controls will be implemented to retain sediment onsite to the greatest extent practicable. Erosion and sediment runoff will be controlled through the use of structural and/or stabilization practices, good housekeeping, and maintenance of sediment pond capacity. (ER Section 5.10.3.3)

- Measures such as leak detection systems and drip pans will be taken to control discharges of pollutant sources onsite and offsite from fueling stations and vehicle maintenance operations. Runoff from excavated areas and associated stockpiles will be contained or appropriately diverted. Housekeeping practices will ensure containment of onsite materials and proper treatment of trash. (ER Section 5.10.3.4)

- Local, State, and Federal traffic requirements onsite and offsite from active facility operations will be adhered to for traffic control. (ER Section 5.10.3.5)

- Transmission line right-of-way operation and maintenance activities will be conducted in a manner similar to the existing transmission facilities. (ER Section 5.10.3.6.3)

- A target for the Exelon ESP is to maintain a discharge rate within the existing Clinton Dam permit, in which the 0.14-m^3 (5-cfs) minimum discharge from Clinton Lake to Salt Creek will be maintained. Water quality, water temperature, and hydrology will be operated in compliance with NPDES water quality requirements and other Federal laws. (ER Sections 5.10.3.7 and 5.10.3.8; see also Section 5.3)

- Total residual chemical concentrations in the discharges to Clinton Lake from treatment to limit biological growth and for deicing and antiscaling, which are subject to limits established by IEPA, will be selected for their effectiveness and ability to minimize the impacts on water quality. The discharge-monitoring program will be revised, as necessary, to monitor for potential water quality impacts. (ER Section 5.10.3.9)

- Monitoring will be performed, as appropriate and if required, for the presence of thermophilic organisms, and the potential health risk will be evaluated during pre-application monitoring. (ER Section 5.10.3.9.4.1)

- Appropriate construction procedures and best management practices will be utilized to make certain that the adverse impacts to any environmentally sensitive areas or important habitats potentially occurring along the proposed transmission line rights-of-way are avoided. (ER Section 5.10.3.12.1)

- Ground faults will be installed to limit induced currents from the EMF given off by the transmission lines. Sufficient ground rods will be installed to reduce the resistance to 10 ohms or less under normal atmospheric conditions. (ER Section 5.10.3.12.3.4)

Exelon evaluated the measures and controls shown in Section 5.10 of the ER (Exelon 2006a) and considered them feasible from both a technical and economic standpoint. In addition, Exelon expects these measures and controls would be adequate for avoiding or mitigating potential adverse impacts associated with operation of the new units. The staff considered these measures and controls in its evaluation of station operation impacts.

5.12 Summary of Operational Impacts

Impact level categories are denoted in Table 5-15 as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. With the socioeconomic issues for which the impacts are likely to be beneficially MODERATE or LARGE, this is noted in the Comments column. The Impact column designates beneficial impacts as SMALL. Impacts related to the chronic effects of EMFs and accident impacts for the gas-cooled designs are unresolved because of lack of information. An applicant proposing a gas-cooled reactor design at the CP or COL stage that references the Exelon ESP would need to provide this information to enable analysis at that time.

Table 5-15. Characterization of Operational Impacts at the Exelon ESP Site

Category	Comments	Impact Level
Land-use impacts		--
The site and vicinity	Operation of a new nuclear unit within existing site. Possible new housing and retail space added in vicinity due to potential growth.	SMALL
Transmission line rights-of-way	Normal maintenance of upgraded transmission lines in previously existing rights-of-way.	SMALL
Air quality impacts	Cooling tower, meteorological, and transmission line impacts are expected to be negligible. Pollutants emitted during operations considered insignificant and limits could be incorporated under existing Exclusionary Permit.	SMALL
Water-related impacts		
Water use	During normal water years, the impact would be small. During critical low-water years, the impacts could be temporarily moderate.	SMALL to MODERATE
Water quality	Water effluents are regulated by IEPA and the NPDES permit.	SMALL
Ecological impacts		
Terrestrial ecosystems	Impacts from operation of a new nuclear unit, including the associated heat dissipation system, transmission lines, and right-of-way maintenance would be SMALL.	SMALL
Aquatic ecosystems	Exelon's adherence to the NPDES permit would likely result in the maintenance of balanced aquatic populations. Potential impacts during drought years could result in increased impact level up to MODERATE.	Unresolved, likely to be SMALL
Threatened or Endangered species	Operational impacts to Federally listed species are expected to be negligible.	SMALL
Socioeconomic impacts		
Physical impacts		
Workers/public	Workers would use protective equipment, receive training to mitigate any possible impact, and meet applicable Federal/State regulations. Exelon ESP site is relatively remote, the public would not be impacted.	SMALL
Buildings	No anticipated impact to onsite or offsite buildings.	SMALL

Table 5-15. (contd)

Category	Comments	Impact Level
Roads	Roads are two-lane, rural, and lightly traveled and would not be substantially physically impacted by operational workforces.	SMALL
Aesthetics	Visual impact would be minimal due to remote location and sparse population. Visual impacts of operation would be similar to those existing. Could be moderate during severe drought due to consumptive water use.	SMALL to MODERATE
Demography	Number of new employees small in proportion to population base.	SMALL
Impacts to Community - Social and Economic		
Economy	Increased jobs would benefit the area economically, up to a moderate beneficial impact, possibly in DeWitt County.	Beneficially SMALL to MODERATE
Taxes	Depends on residence location; generally, impacts would be beneficial. The potential benefits would generally be SMALL everywhere except DeWitt County where they could be LARGE due to property tax collection from the ESP facility.	Beneficially SMALL to LARGE
Impacts to Community - Infrastructure and Community		
Transportation	Most local roadways are rural, lightly traveled, and well-maintained.	SMALL
Recreation	Overall impacts to recreation minimal. Traffic around and use of lake could increase. Lower water levels, and their effect on shoreline exposure and recreational usage during severe drought, could temporarily impact area, probably at the MODERATE level.	SMALL to MODERATE
Housing	Adequate housing is available to handle operational workers if Exelon’s assumptions on workforce are correct. DeWitt, Piatt, and Logan Counties could have a temporary housing shortage, possibly at the MODERATE impact level.	SMALL to MODERATE
Public Services	Adequate in all counties for any population increase due to operation workforce.	SMALL

Table 5-15. (contd)

Category	Comments	Impact Level
Education	Majority of workers are expected to be from within the region. Current schools could handle any additional students.	SMALL
Historic and cultural resources	A cultural resource procedure is in place for minimizing impacts from routine land disturbances.	SMALL
Environmental justice	No unusual resource dependence in the area.	SMALL
Nonradiological health impacts	Small estimated lake temperature increase would not significantly increase abundance of thermophilic microorganisms. Health impacts of noise, EMF, and occupational injuries would be monitored and controlled in accordance with OSHA regulations.	SMALL Unresolved for chronic effects of EMF
Radiological health impacts	Doses to the public and occupational workers would be monitored and controlled in accordance with NRC limits.	SMALL
Impacts of postulated accidents		
Design basis accidents	Doses for new advanced LWRs are expected to be a small fraction of the regulatory dose limits. Staff would verify that doses for postulated DBAs on chosen reactor designs are within regulatory limits.	SMALL for LWR Unresolved for gas-cooled designs
Severe accidents	Risks would be small.	SMALL for LWR Unresolved for gas-cooled design

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6.0 Fuel Cycle, Transportation, and Decommissioning

This chapter addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) transportation of radioactive material, and (3) decommissioning for a new nuclear unit at the early site permit (ESP) site. Distinctions between the impacts of advanced light water reactor (LWR) designs and the gas-cooled reactor designs are discussed.

In its evaluation of uranium fuel cycle impacts from a new nuclear unit at the ESP site, Exelon Generation Company, LLC (Exelon) used the plant parameter envelope (PPE) approach for the advanced LWR designs but not for the two gas-cooled reactors. In its evaluation of the impacts from transportation of radioactive materials, however, Exelon did not use the PPE approach but rather evaluated each reactor design individually. Exelon would, therefore, have to perform a new evaluation if a different design is proposed at the construction permit (CP) or combined operating license (COL) stage.

6.1 Fuel Cycle Impacts and Solid Waste Management

This section discusses the environmental impacts from the uranium fuel cycle and solid waste management for both the advanced LWR designs and gas-cooled reactor designs. The impacts of the two types of design are presented separately because Title 10 of the Code of Federal Regulations (CFR), Section 51.51 (10 CFR 51.51) provides specific criteria for evaluating the environmental impacts only for LWR designs. Issues related to fuel cycle impacts and solid waste management are unresolved because of the current lack of data to validate impacts from gas-cooled designs.

6.1.1 Light-Water Reactors

The regulations in 10 CFR 51.51(a) state that

> Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S–3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S–3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

The PPE for a new nuclear unit at the Exelon ESP site uses the bounding input parameters from the following LWR designs:

- Advanced Canada Deuterium Uranium Reactor (ACR-700) – This reactor, developed by Atomic Energy Canada Limited, is an evolutionary extension of the CANDU 6 plant using very slightly enriched uranium fuel and light water coolant.

- Advanced Boiling Water Reactor (ABWR) – This reactor, developed by the General Electric Company, is a standardized plant that has been certified under the U.S. Nuclear Regulatory Commission (NRC) requirements in 10 CFR Part 52. The ABWR is fueled with slightly enriched uranium and uses a light water cooling system. In the fuel cycle analysis, the applicant conservatively assumed the ABWR to be the updated design power level of 4300 MW(t) rather than the certified design power level of 3926 MW(t).

- Advanced Pressurized Water Reactor (AP1000) – This is an earlier version of the AP1000 reactor final design developed by Westinghouse Electric Company and subsequently approved by the NRC, using slightly enriched uranium and a light water cooling system. This design is not the AP1000 that has been certified under the NRC requirements in 10 CFR Part 52; therefore, this design will be referred to as the "surrogate AP1000."

- Economic Simplified Boiling Water Reactor (ESBWR) – This reactor, developed by the General Electric Company, is fueled with slightly enriched uranium and uses a light water cooling system.

- International Reactor Innovative and Secure (IRIS) next-generation pressurized water reactor (PWR) – This reactor, under development by a consortium led by the Westinghouse Electric Company, is a modular LWR.

These light water designs all use uranium dioxide fuel; therefore, Table S–3 (10 CFR 51.51(b)) can be used to assess environmental impacts. Table S–3 values are normalized for a reference 1000-MW(e) LWR at an 80-percent capacity factor. The 10 CFR 51.51(a) Table S–3 values are reproduced in Table 6-1. The PPE power rating for the Exelon ESP site is 6800 MW(t), assuming that two AP1000 units would be located on the ESP site (Exelon 2006), with a PPE capacity factor of 95 percent (INEEL 2003) [which corresponds to 2200 MW(e)].

Specific categories of natural resource use are included in Table S–3 (see Table 6-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high-level and low-level wastes, and radiation doses from transportation and occupational exposures. In developing Table S–3, the staff considered two

Table 6-1. Table S–3 from 10 CFR 51.51(b), Table of Uranium Fuel Cycle Environmental Data[(1)]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1000 MWe LWR
Natural Resource Use		
Land (acres):		
Temporarily committed[2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 100 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through
Fossil fuel:		
Electrical energy (thousands of MW-hr)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of standard cubic feet)	135	<0.4 percent of model 1,000 MWe energy output.
Effluents--Chemical (MT)		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	.014	

Table 6-1. (continued)

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Liquids:		
SO^{-}_{4}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs., NO_3—20 cfs., Fluoride—70 cfs.
NO^{-}_{3}	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
$C1^{-}$	8.5	
Na^{+}	12.1	
NH_3	10.0	
Fe	.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills-no significant effluents to environment.
Effluents--Radiological (curies)		
Gases (including entrainment):		
Rn-222	....	Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99	....	Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	$5.9x10^{-6}$	
Solids (buried on site):		

Table 6-1. (continued)

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S–3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.
Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH—1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG—0116 (Supp.1 to WASH—1248, NRC 1976); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG—0216 (Supp. 2 to WASH—1248) (NRC 1977b); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM—50—3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S–4 of Sec. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S–3A of WASH-1248.
[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.
[3] Estimated effluents based upon combustion of equivalent coal for power generation.
[4] 1.2 percent from natural gas use and process.

fuel cycle options, which differed in the treatment of spent fuel removed from a reactor. "No recycle" treats all spent fuel as waste to be stored at a Federal waste repository; "uranium only recycle" involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in Table S–3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles (uranium only and no recycle); that is, the identified environmental impacts are based on the cycle that results in the greater impact. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

During the Carter administration, the Nuclear Nonproliferation Act of 1978, Pub. L. No. 95-242 (22 USC 3201 et seq.), was enacted; it significantly impacted the disposition of spent nuclear fuel by deferring indefinitely the commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power program. While the ban on the reprocessing of spent fuel was lifted during the Reagan administration, economic circumstances changed, reserves of uranium ore increased, and the stagnation of the nuclear power industry provided little incentive for industry to resume reprocessing. During the 109th Congress, the Energy Policy Act of 2005, Pub. L. No. 109-58 (119 Stat. 594 [2005]), was enacted. It authorized DOE to conduct an advanced fuel recycling technology research and development program to evaluate proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while Federal policy does not prohibit reprocessing, additional DOE efforts would be required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

The no-recycle option is presented schematically in Figure 6-1. Natural uranium is mined in either open-pit or underground mines or by an in situ leach solution mining process. In situ leach mining, the primary form of mining in the United States today, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or in situ leach solution is transferred to mills where it is processed to produce “yellowcake” (U_3O_8). A conversion facility prepares the uranium oxide by converting it to uranium hexafluoride, which is then processed by an enrichment facility to increase the percentage of the more fissile isotope uranium-235 and decrease the percentage of the non-fissile isotope uranium-238. At a fuel-fabrication facility, the enriched uranium, which is approximately 5 percent uranium-235, is then converted to UO_2. The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to produce power. When the content of the uranium-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor. After onsite storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies would be transferred to a waste repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S–3 (see Table 6-1) and the staff’s analysis of the radiological impact from radon-222 and technetium-99. In

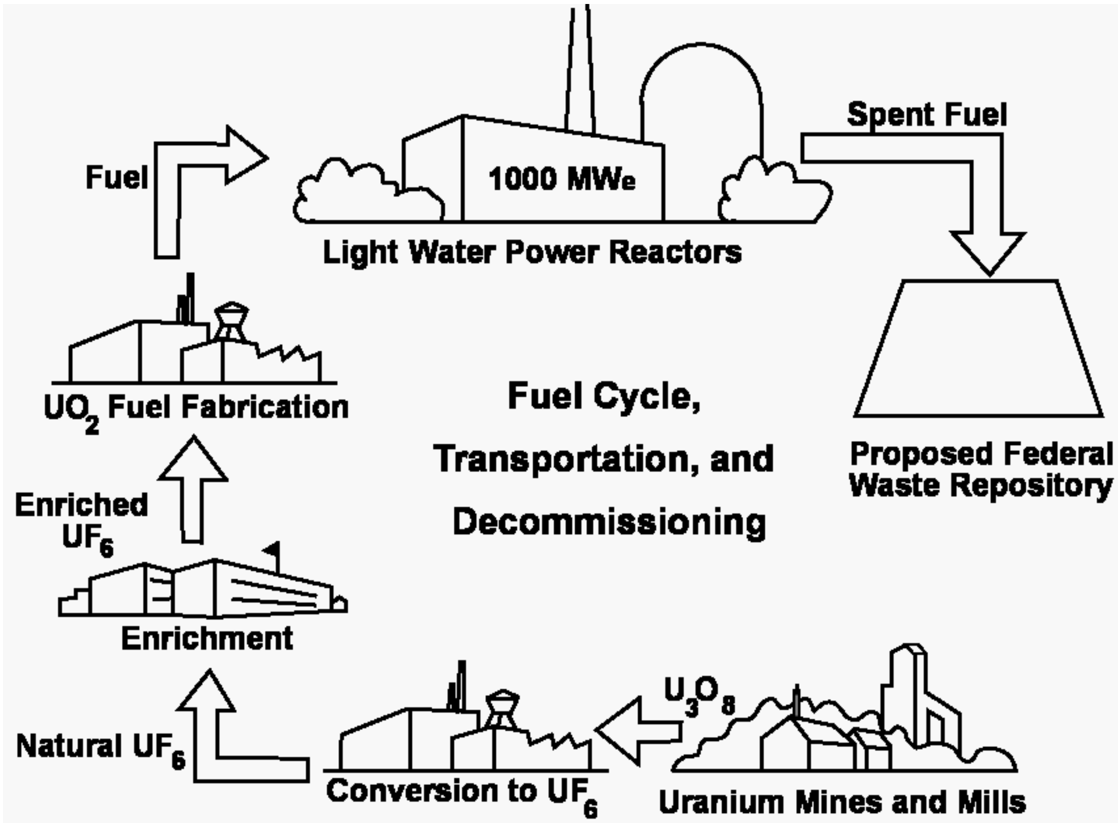

Figure 6-1. The Uranium Fuel Cycle: No-Recycle Option (derived from NRC 1999)

NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996),[(a)] the staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to the impacts related to license renewal, the information is relevant to this review because the advanced LWR designs considered here use the same type of fuel; the staff's analyses in Section 6.2.3 of NUREG-1437 are summarized and set forth here.

The fuel cycle impacts in Table S–3 are based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). In the following review and evaluation of the environmental impacts of the fuel cycle, the staff considered the capacity factor of 95 percent with a total net electric output of 2200 MW(e) for a new nuclear unit at the ESP site (INEEL 2003); this is approximately three times the impact values in

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Table S–3 (see Table 6-1). Throughout this chapter, this will be referred to as the 1000-MW(e) LWR scaled model, reflecting 2200 MW(e) for the site.

Recent changes in the fuel cycle may have some bearing on environmental impacts; however, as discussed below, the staff is confident that the contemporary fuel cycle impacts are below those identified in Table S–3.

The values in Table S–3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be under-estimated. This approach was intended to ensure that the actual environmental impacts would be less than the quantities shown in Table S–3 for all LWR nuclear power plants within the widest range of operating conditions. Many subtle fuel cycle parameters and interactions were recognized by the staff as being less precise than the estimates and were not considered or were considered but had no effect on the Table S–3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S–3, the staff defined the model reactor as a 1000-MW(e) light water cooled reactor operating at 80-percent capacity with a 12-month fuel reloading cycle and an average fuel burnup of 33,000 MWd/MTU. This is a "reactor reference year" or "reference reactor year" depending on the source (either Table S–3 or NUREG-1437), but it has the same meaning. The sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor can be divided by the now-more-likely 60-year lifetime (40-year initial license term and 20-year license renewal term) to obtain an average annual fuel requirement. This was done in NUREG-1437 for both boiling water reactors (BWRs) and PWRs; the higher annual requirement, 35 metric tonnes (MT) of uranium made into fuel for a BWR, was chosen in NUREG-1437 as the basis for the reference reactor year. A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Since Table S–3 was promulgated, these improvements have reduced the annual fuel requirement.

Another change is the elimination of the U.S. restrictions on the importation of foreign uranium. The economic conditions of the uranium market favor utilization of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from these activities. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those given in Table S–3; however, Table S–3 estimates have not been reduced.

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the fuel cycle on the environmental impacts in greater detail.

6.1.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1000-MW(e) LWR scaled model is about 138 ha (339 ac). Approximately 15 ha (39 ac) are permanently committed land, and 123 ha (300 ac) are temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. "Permanent" commitments represent land that may not be released for use after plant shutdown and decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E for release of that area for unrestricted use. Of the 123 ha (300 ac) of temporarily committed land, 96 ha (237 ac) are undisturbed and 27 ha (66 ac) are disturbed. In comparison, a coal-fired power plant using the same MW(e) output as the LWR scaled model and using strip-mined coal requires the disturbance of about 243 ha (600 ac) per year for fuel alone. The staff concludes that the impacts on land use to support the 1000-MW(e) LWR scaled model would be small.

6.1.1.2 Water Use

The principal water use for the fuel cycle supporting a 1000-MW(e) LWR scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S–3, of the total annual water use of 1.29×10^8 m^3 (3.41×10^{10} gal), about 1.26×10^8 m^3 (3.33×10^{10} gal) are required for the removal of waste heat, assuming that a new nuclear unit uses once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 1.82×10^6 m^3/yr (4.80×10^8 gal/yr) and water discharged to ground (e.g., mine drainage) of about 1.44×10^6 m^3/yr (3.81×10^8 gal/yr).

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1000-MW(e) LWR scaled model using once-through cooling. The consumptive water use of 1.8×10^6 m^3/yr (4.8×10^8 gal/yr) is about 2 percent of the 1000-MW(e) LWR scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6 percent of the 1000-MW(e) LWR scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be small.

6.1.1.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5 percent of the annual electric power production of the reference 1000-MW(e) LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the model plant. The staff concludes that the fossil fuel impacts from the direct and indirect consumption of electric energy for fuel cycle operations would be small relative to the net power production of the proposed project.

6.1.1.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel cycle processes are given in Table S–3 (see Table 6-1) for the reference 1000-MW(e) LWR. The quantities of effluents would be approximately three times greater for the reference 1000-MW(e) LWR-scaled model. The principal effluents are SO_x, NO_x, and particulates. Based on data in the *Seventh Annual Report of the Council on Environmental Quality* (CEQ 1976), these emissions constitute a small additional atmospheric loading in comparison with emissions from the stationary fuel combustion and transportation sectors in the United States, which is about 0.06 percent of the annual national releases for each of these effluents.

Liquid chemical effluents produced in fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S–3 (see Table 6-1) specifies the amount of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel cycle operations will be subject to requirements and limitations set by an appropriate Federal, State, regional, local, or affected Native American Tribal regulatory agency.

Tailings solutions and solids are generated during the milling process and are not released in quantities sufficient to have a significant impact on the environment.

The staff determined that the impacts of these chemical effluents would be small.

6.1.1.5 Radioactive Effluents

Radioactive effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle process are set forth in Table S–3 (see Table 6-1). Using these effluents in NUREG-1437 (NRC 1996), the staff calculated the 100-year environmental dose commitment to the U.S. population from the fuel cycle of 1 year of operation of the model 1000-MW(e) LWR. The total overall whole body gaseous dose commitment and whole body liquid dose commitment from the fuel cycle (excluding reactor releases and dose commitments due to radon-222 and technetium-99) were calculated to be approximately 4 person-Sv (400 person-rem) and 2 person-Sv (200 person-rem), respectively. Scaling these dose commitments by a factor of 3 for the 1000-MW(e) LWR scaled model results in whole body dose commitment estimates of 12 person-Sv (1200 person-rem) for gaseous releases and 6 person-Sv (600 person-rem) for liquid releases. For both pathways, the estimated 100-year environmental dose commitment to the U.S. population would be approximately 18 person-Sv (1800 person-rem) for the 1000-MW(e) LWR scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S–3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. Exelon provided an assessment of radon-222 and technetium-99 in its response to a request for additional information on December 13, 2004 (Exelon 2004a). This evaluation relied on the information discussed in NUREG-1437 (NRC 1996).

In Section 6.2 of NUREG-1437 (NRC 1996), the staff estimated the radon-222 releases from mining and milling operations and from mill tailings for each year of operations of the reference 1000-MW(e) LWR. The estimated releases of radon-222 for the reference reactor year for the 1000-MW(e) LWR scaled model, or for the total electric power rating for the site for a year, are approximately 5.8×10^{14} Bq (15,600 Ci). Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tails before stabilization. For radon releases from stabilized tailings, the staff assumed that the scaled model would result in an emission of 1.1×10^{11} Bq (3 Ci) per site year; i.e., three times the NUREG-1437 estimate for the reference reactor year. The major risks from radon-222 are from exposure to the bone and the lung although there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR Part 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated 100-year environmental dose commitment from mining, milling, and tailings before stabilization for each site year (assuming the 1000-MW(e) LWR scaled model) would be approximately 28 person-Sv (2800 person-rem) to the whole body. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 0.52 person-Sv (52 person-rem) to the whole body. Additional insights regarding Federal policy/resource perspectives concerning institutional controls comparisons with routine radon-222 exposure and risk and long-term releases from stabilized tailing piles are discussed in NUREG-1437 (NRC 1996).

Also as discussed in NUREG-1437, the staff considered the potential health effects associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference reactor-year for the 1000-MW(e) LWR scaled model are 7.4×10^{8} Bq (0.02 Ci) from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 5.5×10^{8} Bq (0.015 Ci) into the groundwater from a repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney although there is a small risk from exposure to the whole body. Applying the organ-specific dose weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 to the whole body was estimated to be 3 person-Sv (300 person-rem) for the 1000-MW(e) LWR scaled model.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from International Commission on Radiation Protection (ICRP) Publication 60 (ICRP 1991). This coefficient was multiplied by the sum of the estimated whole body population doses from gaseous effluents, liquid effluents, radon-222, and technetium-99 discussed above, (approximately 49 person-Sv/yr [4900 person-rem/yr]), to calculate that the U.S. population would incur a total of approximately 3.6 fatal cancers, nonfatal cancers, and severe hereditary effects annually. This risk is quite small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that would be estimated to the U.S. population annually from exposure to natural sources of radiation using the same risk estimation method.

Radon releases from tailings are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 1 km in some cases) (NRC Docket 50-488 1986). The public dose limit in the U.S. Environmental Protection Agency (EPA)'s regulation, 40 CFR Part 190, is 0.25 mSv/yr (25 mrem/yr) to the whole body from the entire fuel cycle, but most NRC licensees have airborne effluents resulting in doses of less than 0.01 mSv/yr (1 mrem/yr) (61 FR 65120).

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published "Cancer in Populations Living Near Nuclear Facilities" in 1990 (NCI 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the U.S. in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (NCI 1990). The contribution to the annual average dose received by an individual from fuel cycle-related radiation and other sources as reported in NCRP Report 93 (NCRP 1987) is listed in Table 6-2. The nuclear fuel cycle contribution to an individual's annual average radiation dose is extremely small (less than 0.01 mSv [1 mrem] per year).

Based on the analyses presented above, the staff concludes that the environmental impacts of radioactive effluents from the fuel cycle are small.

6.1.1.6 Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S–3 (see Table 6-1). For low-level waste disposal at land burial facilities, the Commission notes in Table S–3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a repository, such as the candidate repository at Yucca Mountain, Nevada, and that no release to the environment is expected to be associated with such disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. In NUREG-0116 (NRC 1976), which provides background and context for the high-level and transuranic Table S–3 values established by the Commission, the staff indicates that these high-level and transuranic wastes will be buried and will not be released to the environment.

Table 6-2. Comparison of Annual Average Dose Received by an Individual from All Sources

	Source	Dose (mSv/yr)[(a)]	Percent of Total
Natural			
	Radon	2	55
	Cosmic	0.27	8
	Terrestrial	0.28	8
	Internal (body)	0.39	11
	Total natural sources	3	82
Artificial			
	Medical x-ray	0.39	11
	Nuclear medicine	0.14	4
	Consumer products	0.10	3
	Total artificial sources	0.63	18
Other			
	Occupational	0.009	<0.30
	Nuclear fuel cycle	<0.01	<0.03
	Fallout	<0.01	<0.03
	Miscellaneous sources	<0.01	<0.03

(a) To convert mSv/yr to mrem/yr, multiply by 100.
Source: NCRP Report 93, *Ionizing Radiation Exposure of the Population of the United States* (NCRP 1987)

On February 15, 2002, subsequent to receipt of a recommendation by Secretary Abraham, U.S. Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste (White House Press release 2002).

The EPA developed Yucca Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000-year period (U.S. Court of Appeals 2004). The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court's decision, EPA issued its proposed revised standards on August 22, 2005, that would revise the radiation protection standards for the candidate repository (70 FR 49014). In order to be consistent with EPA's revised standards, NRC proposed revisions to 10 CFR Part 63 on September 8, 2005 (70 FR 53313). The 10 CFR Part 63 rulemaking, RIN 3150-AH68, is titled "Implementation of a Dose Standard after 10,000 years," and the comment period was extended to December 7, 2005. The proposed standards are 0.15 mSv (15 mrem) per year for 10,000 years following disposal and 3.5 mSv (350 mrem) per year for 10,000 years through 1-million years after disposal. RIN 3150 will not be finalized by the time this EIS is issued.

Consequently, at this time, for the high-level waste and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, the staff assumed that limits were developed along the lines of the 1995 National Academy of Sciences report, *Technical Bases for Yucca Mountain Standards*, and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site that will comply with such limits, with peak doses to virtually all individuals of 100 millirem (1 mSv) per year or less (NAS 1995; NRC 1996).

Despite the current uncertainty with respect to these rules, some judgment as to the National Environmental Policy Act of 1969 (NEPA) implications of offsite radiological impacts of spent fuel and high-level waste disposal should be made. The staff concludes that these impacts are acceptable in that the impacts would not be sufficiently large to require the NEPA conclusion that the construction and operation of a new nuclear unit at the ESP site should be denied.

Section 6.2 of NUREG-1437 (NRC 1996) describes the generation, storage, and ultimate disposal of low-level waste, mixed waste, and spent fuel from power reactors. For the reasons stated above, the staff concludes that the environmental impacts of radioactive waste disposal are small.

6.1.1.7 Occupational Dose

In the review and evaluation of the environmental impacts of the fuel cycle, the staff considered the higher capacity factor of 95 percent with a total net electric output of 2200 MW(e) for a new nuclear unit at the ESP site (INEEL 2003). This is referred to as the 1000-MW(e) LWR scaled model. The annual occupational dose attributable to all phases of the fuel cycle for the 1000-MW(e) LWR scaled model is about 18 person-Sv (1800 person-rem). This is based on a 6 person-Sv (600 person-rem) occupational dose estimate attributable to all phases of the fuel cycle for the model 1000 MW(e) LWR (NRC 1996). The environmental impact from this occupational dose is considered small because the dose to any individual worker is maintained within the limits of 10 CR Part 20, which is 0.05 Sv/yr (5 rem/yr).

6.1.1.8 Transportation

The transportation dose to workers and the public totals about 0.025 person-Sv (2.5 person-rem) annually for the reference 1000-MW(e) LWR per Table S–3 (see Table 6-1). This corresponds to a dose of 0.075 person-Sv (7.5 person-rem) for the 1000-MW(e) LWR-scaled model. For comparative purposes, the estimated collective dose from natural background radiation to the population within 80 km (50 mi) of the Exelon ESP site is 2300 person-Sv/yr (230,000 person-rem/yr) (Exelon 2006). On the basis of this comparison, the staff concludes that environmental impacts of transportation would be small.

6.1.1.9 Conclusion

The staff evaluated the environmental impacts of the uranium fuel cycle as given in Table S–3 (see Table 6-1), considered the effects of radon-222 and technetium-99, and appropriately scaled the impacts for the 1000-MW(e) LWR scaled model. Based on this evaluation, the staff concludes that the impacts would be SMALL and that mitigation would not be warranted.

6.1.2 Gas-Cooled Reactors

As noted earlier, issues related to reactors based on non-LWR designs are unresolved because of the lack of information to validate values and impacts. However, the following analyses were performed using data from Exelon for the purposes of estimation only.

The gas-cooled reactors analyzed for the uranium fuel cycle are:

- Gas Turbine Modular Helium Reactor (GT-MHR) – This reactor, developed by General Atomics, is a modular helium-cooled graphite-moderated reactor.

- Pebble Bed Modular Reactor (PBMR) – This reactor, developed by PBMR (Pty), Ltd., is a modular graphite-moderated helium-cooled gas turbine reactor.

Table S–3 from 10 CFR 51.51(b) (see Table 6-1) can be used as a basis for bounding the environmental impacts from the uranium fuel cycle only for LWRs. Exelon performed an assessment of the environmental impacts of the fuel cycle for gas-cooled reactor designs by comparing key parameters for these reactor designs to those used to generate the impacts in Table S–3 (Exelon 2006). Key parameters are energy usage, material involved, and number of shipments for each major fuel cycle activity (i.e., mining, milling, conversion, enrichment, fuel fabrication, and radioactive waste disposal). Exelon sought to demonstrate in its ER that the impacts for the gas-cooled reactor designs were comparable to the environmental impacts identified in the technical basis document, WASH-1248, "Environmental Summary of the Uranium Fuel Cycle" (AEC 1974) and its Supplement 1 (NUREG-0116) (NRC 1976) for Table S–3.

As discussed in Section 6.1.1, the fuel cycle impacts in Table S–3 (see Table 6-1) were based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). This is termed the "reference reactor year." For the purposes of evaluating fuel cycle impacts for a new nuclear unit at the Exelon ESP site, it was assumed that the additional LWR site-wide fuel impacts would be based on a total net electric output of 2200 MW(e) at 95 percent annual capacity factor. This was termed the 1000-MW(e) LWR scaled model and resulted in a factor about 3 times (i.e., 2200/800) the impacts in Table S–3.

One of the other-than-LWRs considered by Exelon, the GT-MHR, is a four-module, 2400-MW(t), nominal 1140-MW(e) unit assumed to operate at an annual capacity factor of 88 percent for a net electric output of 1003 MW(e). Therefore, the maximum number of GT-MHR units that could be sited at the Exelon ESP site and remain below the 2200-MW(e) total net electric output PPE for the site is two (i.e., 2 x 1003).

The second other-than-LWR considered by Exelon, the PBMR, is an eight-module, 3200-MW(t), nominal 1320-MW(e) unit assumed to operate at an annual capacity factor of 95 percent for a net electric output of 1253 MW(e). Therefore, the comparable number of PBMR units to remain below the 2200-MW(e) total net electric output PPE for the site is one (i.e., 1 x 1253).

Exelon (2006) compared the impacts in Table S–3 LWR with those of the gas-cooled reactor designs. The comparison used an annual fuel loading as a starting point and then proceeded in reverse direction through the fuel cycle (i.e., fuel fabrication, enrichment, conversion, milling, mining, radioactive waste). Table 6-3 provides an estimate of the impacts for each phase of the uranium fuel cycle, assuming that the ESP site would host two four-module GT-MHR units or one eight-module PBMR unit.

Table 6-3. Fuel Cycle Environmental Impacts from Gas-Cooled Reactor Designs for the Exelon ESP Site[(a)]

Reactor Technology Facility/Activity	GT-MHR, 4 Modules (2400 MW(t) total ≈1140 MW(e) total; 88 percent capacity: multiplier=2)	PBMR, 8 Modules (3200 MW(t) total ≈1320 MW(e) total; 95 percent capacity: multiplier=1)
Mining Operations		
Annual ore supply (MT)	674,280	337,140
Milling Operations		
Annual yellowcake (MT)	606	303
UF_6 Production		
Annual UF_6 (MT)	758	379
Enrichment Operations		
Enriched UF_6 (MT)	16	12.3
Annual separative work units (MT)	408	194
Fuel Fabrication Plant Operations		
Enriched UO_2 (MT)	12.2	9.5
Annual fuel loading (MTU)	10.8	8.3
Solid Radioactive Waste		
Annual low-level waste from reactor operations (Ci)	2200 Ci[(b)]; 196 m^3	65.4 Ci[(b)]; 800 drums
Low-level waste from reactor decontamination and decommissioning (Ci per reference reactor-year)	Data not available	2.2×10^4

(a) Values calculated by multiplying values from Table 5.7-1 of ER (Exelon 2006) by multiplier.
Notes:
- The enrichment separative work units (SWU) calculation was performed using the United States Enrichment Corporation, Inc., SWU calculator and assumes a 0.30 percent tails assay.
- The information on the reference reactor (mining, milling, UF_6, enrichment, fuel fabrication values) was taken from NUREG-0116, Table 3.2, no recycling (NRC 1976).
- The information on the reference reactor (solid radioactive waste) was taken from 10 CFR 51.51, Table S–3.
- The calculated information on the reference reactor uses the same methodology as for the reactor technologies.
- The normalized information is based on 1000 MW(e) and the reactor vendor-supplied unit capacity factor.
- For the new reactor technologies, the annual fuel loading was provided by the reactor vendor.
- The SWU calculator also calculated the kilograms of uranium feed. This number was multiplied by 1.48 to get the necessary amount of UF_6.
- The annual yellowcake number was generated using the relationship 2.61285 lb. of U_3O_8 to 1 kg U of UF_6; 1.185 kg of U_3O_8 to 1.48 kg.
- The annual ore supply was generated assuming an 0.1-percent ore body and a 90-percent recovery efficiency.
- Cobalt-60 with a 5.26-yr half-life and iron-55 with a 2.73-yr half-life are the main nuclides listed for the PBMR decontamination and decommissioning waste.

(b) To convert from Ci to Bq, multiply by 3.7×10^{10}.

6.1.2.1 Fuel Fabrication

The quantity of UO_2 required for reactor fuel is a key parameter. The more UO_2 required, the greater the environmental impacts (i.e., more energy, greater emissions, and increased water usage). The 1000-MW(e) LWR scaled model described in Section 6.1.1 would require the equivalent of 120 MT of enriched UO_2 annually. This compares to 9.5 to 12.2 MT of enriched UO_2 annually for the gas-cooled reactor technologies.

GT-MHR fuel consists of microspheres of uranium oxycarbide coated with multiple layers of pyrocarbon and silicon carbide referred to as TRISO coating. Two types of microspheres are used in the GT-MHR fuel, one enriched to 19.8-percent uranium-235 and one with natural uranium. The microspheres and graphite shims are bound together into a rod-shaped compact, which is stacked into graphite blocks referred to as fuel elements. A reactor core consists of 1020 fuel elements.

PBMR fuel consists of UO_2 kernels (enriched to 12.9-percent uranium-235) that are TRISO coated, similar to the GT-MHR fuel. The TRISO-coated particles are imbedded into a graphite matrix to form a fuel sphere that is 60 millimeters in diameter. Each fuel sphere contains approximately 15,000 TRISO-coated particles. Approximately 260,000 fuel spheres make up a core of a single reactor module.

The fuel described above for gas-cooled reactors is fabricated differently than fuel for LWRs. There are no currently operating large-scale fuel fabrication facilities producing gas-cooled reactor fuels in the United States; thus, a direct comparison of environmental impacts is not possible. Based on some environmental impacts from a small-scale fuel fabrication facility producing gas-cooled reactor fuel, Exelon concluded that the environmental impacts from producing gas-cooled reactor fuel would be “not inconsistent” with those of LWRs (Exelon 2006). By comparison with the fuel fabrication impacts for LWR technologies, the staff concludes that the environmental impacts from producing gas-cooled reactor fuel likely would be small, but these impacts will need to be assessed at the CP or COL stage, when the staff will consider the environmental data that is available on a large-scale, fuel fabrication facility for gas-cooled reactors.

6.1.2.2 Enrichment

Exelon (2006) identified two quantities of interest for enrichment. These were (1) the amount of energy required to enrich the fuel measured in separative work units (SWUs), and (2) the amount of uranium hexafluoride (UF_6) needed. A SWU is a measure of energy required to enrich the fuel. The major environmental impacts for the entire uranium fuel cycle are from the emissions of the fossil fuel plants used to supply energy for the gaseous diffusion plants that enrich the uranium. An enrichment technology developed since the impacts in Table S–3 (see Table 6-1) were evaluated includes the gas centrifuge process that uses 90 percent less energy than the gaseous diffusion process NRC (1996).

In order to produce the 40 MT of enriched UO_2 for the reference LWR in WASH-1248, the enrichment plant needed to produce 52 MT of UF_6, which required 127 MT of SWU (NRC 1976). Therefore, to produce 120 MT of enriched UO_2 for the 1000-MW(e) LWR scaled model, the enrichment plant needs to produce about 156 MT of UF_6, which requires approximately 400 MT of SWU. For gas-cooled reactor technologies, the needed enriched UF_6 ranges from 12.3 to 16 MT of UF_6. The amount of energy to produce these quantities of enriched UF_6 for the gas-cooled reactor designs ranges from 194 to 408 MT of SWU. The upper range is slightly higher than the energy required for the reference LWR. Exelon (2006) concluded that the large reduction in energy associated with using an alternate enrichment technology (e.g., centrifuge) and its associated environmental impacts would more than offset the increase in SWUs. The staff concludes that, on balance, the environmental impacts of enriching gas-cooled fuels by comparison with the impacts of enriching LWR fuel would likely be small, but these impacts will need to be assessed at the CP or COL stage, when the staff will consider impacts from the enrichment technology in use at that time.

6.1.2.3 Uranium Hexafluoride Production – Conversion

There are two uranium conversion processes: a wet and a dry process. In NUREG-1437 (NRC 1996), the NRC stated that environmental releases from the conversion facilities are small compared to the overall fuel cycle impacts and that changing from 100-percent use of one process to 100-percent use of the other would make no significant difference in the overall impacts. Conversion technologies that would be used today to produce UF_6 are similar to those considered when determining the environmental impacts that are part of Table S–3 of 10 CFR 51.51(b) (see Table 6-1).

The conversion facility would need to produce 1080 MT of UF_6 annually for the reference 1000-MW(e) LWR scaled model, compared to 379 to 758 MT of UF_6 for the gas-cooled reactors based on the SWU calculator (Exelon 2006; see Table 6-3, note a, above). The other-than-LWR values are less than the amount of UF_6 required for the LWR; therefore, the associated environmental impacts are expected to be comparable. On this basis, the staff concludes that the environmental impacts from producing UF_6 for gas-cooled reactors would be small.

6.1.2.4 Uranium Milling

Annual yellowcake (U_3O_8) production is the metric of interest for uranium milling. Plants requiring less yellowcake production than the reference plant would require less energy, have fewer emissions, and use less water.

The uranium mill for the 1000-MW(e) LWR scaled model would produce about 900 MT of yellowcake. The uranium mill for the gas-cooled reactor technologies would need to produce 303 to 606 MT of yellowcake, which is less than the amount of yellowcake needed for the scaled LWR (Exelon 2006). On this basis, the staff concludes that the environmental impacts from uranium milling for the gas-cooled reactors would be small.

6.1.2.5 Uranium Mining

Annual ore supply is the metric of interest for uranium mining. The less ore mined, the smaller the environmental impacts (i.e., less energy used, fewer emissions, less water usage). For the 1000-MW(e) LWR scaled model, 816,000 MT of raw ore would be required to produce 900 MT of yellowcake. For the gas-cooled reactor technologies, the scaled ore requirements range from 337,140 to 674,280 MT of ore, a range that is less than the amount of ore required for the reference 1000-MW(e) LWR scaled model. For this reason, the staff concludes that the environmental impacts from uranium mining for the gas-cooled reactors would be small.

6.1.2.6 Solid Low-Level Radioactive Waste – Operations

Table S–3 (see Table 6-1) of 10 CFR 51.51(a) states that there are 3.4×10^{14} Bq (9100 Ci) of low-level waste generated annually from operation of the reference LWR; operation of the 1000-MW(e) LWR scaled model would result in 1×10^{15} Bq (27,300 Ci) of low-level waste annually. Gas-cooled reactor technologies are projected to generate 2.4×10^{12} Bq to 8.1×10^{13} Bq (65.4 to 2200 Ci) of low-level waste scaled annually, far below the amounts generated by the reference LWR. For this reason, the staff concludes that the environmental impacts from low-level radioactive waste operations for gas-cooled reactors would be small.

6.1.2.7 Solid Low-Level Radioactive Waste – Decontamination and Decommissioning

In Table S–3 (see Table 6-1), the Commission states that 5.6×10^{13} Bq (1500 Ci) per reference-reactor year "...comes from reactor decontamination and decommissioning — buried at land burial facilities." Exelon (2006) notes that gas-cooled reactor technologies would (1) generate less waste than the reference 1000-MW(e) LWR, and (2) produce less heavy metal radioactive waste due to the higher thermal efficiency and higher fuel burnup. The gas-cooled reactor designs are also more compact than the reference LWR design, which would be expected to result in less decontamination and decommissioning waste (Exelon 2006). Exelon expects that low-level waste impact from decontamination and decommissioning will be comparable to or less than that of the reference LWR (Exelon 2006). On this basis, the staff concludes that the environmental impacts from solid low-level radioactive waste generated during decontamination and decommissioning for gas-cooled reactors would likely be small, but these impacts will need to be assessed again at the CP or COL stage.

6.1.2.8 Conclusions

The staff expects that the environmental impacts from the uranium fuel cycle activities and solid waste management activities for the proposed gas-cooled reactors would be SMALL. However, because of the uncertainty in the final design of the gas-cooled reactors and the change in technology that could be applied to uranium fuel cycle activities, this issue is unresolved. Should an applicant reference one of these designs, additional staff reviews would be needed at the CP or COL stage in the following areas: fuel fabrication, enrichment, and solid low-level waste operation during decontamination and decommissioning.

6.2 Transportation of Radioactive Materials

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to a nuclear unit at the Exelon ESP site, (2) shipment of spent fuel to a monitored retrievable storage facility or a permanent repository, and (3) shipment of low-level radioactive waste and mixed waste to offsite disposal facilities, as well as the transportation impacts of advanced LWR designs and gas-cooled reactor designs.

The NRC evaluated the environmental effects of fuel and waste for light water reactors in WASH-1238 (AEC 1972) and NUREG-75/038 (NRC 1975) and found the impact to be SMALL. These documents provided the basis for Table S–4 in 10 CFR 51.52, which summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MW(t) (1000 to 1500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100-MW(e) LWR.

Dose to transportation workers during normal transportation operations were estimated to result in a collective dose of 0.04 person-Sv (4 person-rem) per reference reactor year. The combined dose to the public along the route and dose to onlookers were estimated to result in a collective dose of 0.03 person-Sv (3 person-rem) per reference reactor year. Environmental risks (radiological) during accident conditions were determined to be small. Nonradiological impacts during accident conditions were estimated as 1 fatal injury in 100 reference reactor years and 1 nonfatal injury in 10 reference reactor years. Subsequent reviews of transportation impacts in

NUREG-0170 (NRC 1977a) and Sprung et al. (2000) concluded that impacts were bounded by Table S–4 in 10 CFR 51.52.

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts is not required when licensing an LWR (i.e., impacts are assumed bounded by Table S–4) if an LWR meets the following criteria:

- The reactor has a core thermal power level not exceeding 3800 MW(t)

- Fuel is in the form of sintered UO_2 pellets having a uranium-235 enrichment not exceeding 4 percent by weight, and pellets are encapsulated in zirconium-clad fuel rods

- Average level of irradiation of the fuel from the reactor does not exceed 33,000 MWd/MT, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor

- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form

- Unirradiated fuel is shipped to the reactor by truck; irradiated fuel is shipped from the reactor by truck, rail, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or rail.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically in 10 CFR 51.52, provided that the specific conditions in the rule (see above) are met; if not, then a full description and detailed analysis is required for initial licensing. The NRC may consider requests for licensed plants to operate at conditions above those in the facility's licensing basis, for example, higher burnups (above 33,000 MWd/MTU), enrichments (above 4 percent uranium-235), or thermal power levels (above 3800 MW(t)).

Exelon has not identified a specific reactor design for the Exelon ESP site but used bounding parameters from seven reactor designs. Five of the designs are LWRs and include the ACR-700 (3964 MW(t)/unit); the ABWR (4300 MW(t)/unit); the AP1000 (3400 MW(t)/unit); the ESBWR (4000 MW(t)/unit); and the IRIS (3000 MW(t)/unit). For the ACR-700, two reactors make up a unit. For the IRIS design, three reactors (modules) make up a unit. For the remaining LWR designs, one reactor makes up a unit.

None of the proposed LWR designs meets all the conditions in 10 CFR 51.52(a); therefore, a full description and detailed analysis are required for each LWR design. This conclusion is based on the following:

- Departures from the conditions itemized in 10 CFR 51.52(a) must be supported by a full description and detailed analysis of the environmental effects of transporting fuel and radioactive waste to and from the reactor, as specified by 10 CFR 51.52(b).

- Some designs exceed the 3800-MW(t) core thermal power-level limit – the ACR-700 (3964 MW(t)/unit, with two modules, each producing 1982 MW(t)), ABWR (single-module unit producing 4300 MW(t)), AP1000 (6800 MW(t)/unit, with two modules, each producing 3400 MW(t), and ESBWR (single-module unit producing 4300 MW(t)).

- The ABWR, AP1000, ESBWR, and IRIS designs require fuel that exceeds the uranium-235 enrichment of 4 percent.

- The ABWR, AP1000, ESBWR, and IRIS designs are expected to exceed the average irradiation level of 33,000 MWd/MTU.

The remaining two designs are gas-cooled reactors: the GT-MHR and the PBMR. Each GT-MHR unit is a four-module, 2400-MW(t), 1140-MW(e) gas-cooled reactor designed to operate at a unit capacity factor of 88 percent. Each PBMR is an eight-module, 3200-MW(t), 1320-MW(e) gas-cooled reactor designed to operate at a unit capacity factor of 95 percent. This compares to the reference reactor in WASH-1238 (AEC 1972), which is a single-unit, 1100-MW(e) LWR with a unit capacity factor of 80 percent. The gas-cooled reactor designs do not meet the conditions in 10 CFR 51.52 because these reactors are not LWR designs upon which Table S–4 impacts were based. Therefore, a full description and detailed analysis was required for each gas-cooled reactor design. This was provided by Exelon in its response to a request for additional information on September 23, 2004 (Exelon 2004b).

Exelon used a sensitivity analysis to show that transportation impacts from advanced LWR designs would be bounded by the criteria identified in Table S–4 (Exelon 2006). The GEIS Addendum 1 (NRC 1999) was referenced as the basis for exceeding 4-percent uranium-235 enrichment and 33,000 MWd/MTU. However, the GEIS, Addendum 1 applies to reactors that are listed in the GEIS, Appendix A, which does not address advanced reactors.

Exelon also used a sensitivity analysis to show that transportation impacts from the advanced gas-cooled reactor designs would be bounded by the criteria identified in Table S–4 (Exelon 2006); however, as discussed previously, this type of analysis does not adequately meet the requirements of 10 CFR 51.52. Exelon (2006) identified the major contributors to transportation risk to be the number and type of shipments (shipment risk) and the kind of material being shipped (material risk). Its evaluation of shipment risk showed that fewer shipments of unirradiated fuel, spent fuel, and low-level waste would be required for the advanced gas-cooled reactors compared to the reference LWR when averaged over 40 years of operation. Regarding material risk, Exelon (2004b) concluded the following:

- The estimated total spent fuel radioactive inventory and fission product inventory was less for the gas-cooled reactors when compared to the reference LWR.

- Actinide inventories would be greater for the gas-cooled reactors (55 to 65 percent greater) due to the increased burnup for these types of reactors; however, because the GT-MHR was assumed to ship about one-third less spent fuel on a MTU basis, Exelon (2004b) determined that the actinide inventory per shipment would be about one-half that in the reference LWR shipment. The PBMR is assumed to ship the same amount of spent fuel in a spent fuel shipping cash as the reference LWR, so there is about a 60-percent increase in actinide inventories from PBMR spent fuel shipments relative to the reference LWR.

- Gas-cooled reactors would generate fewer kilowatts of decay heat per MTU and fewer kilowatts of decay heat per truck cask at the time of shipment.

6.2.1 Transportation of Unirradiated Fuel

The staff performed an independent review of the environmental impacts of transporting unirradiated (fresh) fuel to the Exelon ESP site. Environmental impacts of normal operating conditions and transportation accidents are discussed in this section. Appendix G provides the details of the analysis.

6.2.1.1 Normal Conditions

Normal conditions, sometimes referred to as “incident-free” transportation, are transportation activities in which shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the unirradiated fuel shipping casks.

Truck Shipments

Table 6-4 provides an estimate of the number of truck shipments of unirradiated fuel for each advanced reactor design compared to those of the reference 1100-MW(e) reactor specified in WASH-1238 (AEC 1972). Estimates are normalized for an equivalent 1100-MW(e) generating capacity. The basis for the shipment estimates can be found in Appendix G of this EIS. Only

Table 6-4. Numbers of Truck Shipments of Unirradiated Fuel for Each Advanced Reactor Type

Reactor Type	Number of Shipments per Reactor Unit			Unit Electric Generation, MW(e)[c]	Capacity Factor[c]	Normalized, Shipments per 1100 MW(e)[d]
	Initial Core[a]	Annual Reload	Total[b]			
Reference LWR (WASH-1238)	18	6	252	1100	0.8	252
ABWR/ESBWR	30	6.1	267	1500	0.95	165
AP1000	28	7.6	322	2300[e]	0.95	130
ACR-700	30	15.4	628	1462[f]	0.9	420
IRIS	34	4.3	201	1005[g]	0.96	184
GT-MHR	51	20	831	1140[h]	0.88	729
PBMR	44	20	824	1320[i]	0.95	579

NOTE: The reference LWR shipment values have all been normalized to 880-MW(e) net electrical generation.
(a) Shipments of the initial core have been rounded up to the next highest whole number.
(b) Total shipments of unirradiated fuel over a 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
(c) Unit capacities and capacity factors were taken from INEEL (2003).
(d) Normalized to net electric output for WASH-1238 reference LWR (i.e., 1100-MW(e) facility at 80 percent or net electrical output of 880 MW(e)). Ranges of capacities given in INEEL (2003) for fresh fuel shipments were derived using the upper limit of the ranges.
(e) The AP1000 site includes two reactors at 1150 MW(e) per reactor.
(f) The ACR-700 unit includes two reactors at 731 MW(e) per reactor.
(g) The IRIS unit includes three reactors at 335 MW(e) per reactor.
(h) The GT-MHR unit includes four reactors at 285 MW(e) per reactor.
(i) The PBMR unit includes eight reactors at 165 MW(e) per reactor.

the ACR-700 (two units), AP1000 (two units), PBMR, and GT-MHR reactor designs exceeded the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238 (AEC 1972). The largest number of shipments, in excess of 700 shipments over 40 years, is for the GT-MHR. However, the combined annual shipments of unirradiated fuel, spent fuel, and radioactive waste equate to far less than the one truck shipment per day specified in Table S–4 of 10 CFR 51.52 for all reactor types.

Shipping Mode and Weight Limits

To comply with the conditions of 10 CFR 51.52(a)(5), all unirradiated fuel must be shipped to the reactor by truck. In information provided by Exelon, Exelon specifies that unirradiated fuel will be shipped to the reactor site by truck for all reactor designs that it references (INEEL 2003). In addition, pursuant to 10 CFR 51.52(c), truck shipments must not exceed 33,100 kg (73,000 lb), as governed by Federal or State gross vehicle weight restrictions. All the advanced reactor designs would meet this weight restriction for unirradiated fuel (INEEL 2003).

Radiological Doses to Transport Workers and the Public

10 CFR 51.52, Table S–4, includes conditions related to radiological dose to transport workers and members of the public along transport routes. These doses are a function of many variables, including the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit (including travel and stop times), and the number of shipments to which the individuals are exposed. For this EIS, the radiological dose impacts of the transportation of unirradiated fuel were calculated for the worker and the public using the RADTRAN 5 computer code (Neuhauser et al. 2003). Details of the calculations are found in Appendix G.

Table 6-5 presents the radiological impacts from the advanced reactor designs to workers, public onlookers (persons at stops and sharing the road), and members of the public along the route (i.e., residents within 800 m [0.5 mi] of the highway). The cumulative annual dose estimates in Table 6-5 were normalized to 1100 MW(e). The NRC staff performed an independent review and determined that all dose estimates are bounded by the Table S–4 conditions of 0.04 person-Sv/yr (4 person-rem/yr) to transportation workers, 0.03 person-Sv/yr (3 person-rem/yr) to onlookers, and 0.03 person-Sv (3 person-rem) to members of the public along the route.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing

Table 6-5. Radiological Impacts of Transporting Unirradiated Fuel to Advanced Reactor Sites

Plant Type	Normalized Average Annual Shipments	Cumulative Annual Dose, person-Sv/yr per 1100 MW(e)[(a)]		
		Workers	Public - Onlookers	Public - Along Route
Reference LWR (WASH-1238)	6.3	1.1×10^{-4}	4.2×10^{-4}	1.0×10^{-5}
ABWR/ESBWR	4.1	7.1×10^{-5}	2.7×10^{-4}	6.6×10^{-6}
AP1000	3.3	5.6×10^{-5}	2.2×10^{-4}	5.2×10^{-6}
ACR-700	10.5	1.8×10^{-4}	7.0×10^{-4}	1.7×10^{-5}
IRIS	4.6	7.9×10^{-5}	3.1×10^{-4}	7.4×10^{-6}
GT-MHR	18.2	3.1×10^{-4}	1.2×10^{-3}	2.9×10^{-5}
PBMR	14.5	2.5×10^{-4}	9.6×10^{-4}	2.3×10^{-5}
10 CFR 51.52, Table S–4 condition	<1 per day	4.0×10^{-2}	3.0×10^{-2}	3.0×10^{-2}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response model. This theory states that any increase in dose, no matter how small, results in an incremental increase in health risk. NRC accepts this theory as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1000 person-rem]) from ICRP Publication 60 (ICRP 1991). All the public doses presented in Table 6-5 are less than or equal to 1.2×10^{-3} person-Sv/yr (1.2×10^{-1} person-rem/yr); therefore, the total detriment estimates associated with these doses would all be less than 1×10^{-4} fatal cancers, nonfatal cancers, and severe heredity effects per year. These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would be expected to occur annually in the same population from exposure to natural sources of radiation.

Maximally Exposed Individuals Under Normal Transport Conditions

A scenario-based analysis was conducted to develop estimates of incident-free radiation doses to maximally exposed individuals (MEIs). The analysis is based on DOE (2002) and incorporates information about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the fuel and waste shipments addressed in this EIS. In all cases, it was assumed that the dose rate emitted from the shipping containers is 0.1 mSv/hr (10 mrem/hr) at 2 m (6.6 ft) from the side of the transport vehicle, the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations, even though unirradiated fuel and radioactive waste will have much lower dose rates than the regulations allow. An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the advanced reactor site. The analysis is described below.

Truck Crew Member

Truck crew members would receive the highest radiation doses during incident-free transport because of their proximity to the loaded shipping container for an extended period of time. The analysis assumed that crew member doses are limited to 0.02 Sv (2 rem) per year, which is the DOE administrative control level (DOE 2002). This limit is anticipated to apply to spent nuclear fuel shipments to a disposal facility, as DOE will take title to the spent fuel at the reactor site. Spent nuclear fuel represents the bulk of the fuel and waste shipments to/from advanced reactor sites and those with the highest radiation dose rates, so crew doses from unirradiated fuel and radioactive waste shipments will be lower than the spent nuclear fuel shipments. The NRC limit for occupational exposures is 0.05 Sv/yr (5 rem/yr).

Inspectors

Radioactive shipments are inspected by Federal or state vehicle inspectors, for example, at state ports of entry. DOE (2002) assumed that inspectors would be exposed for 1 hour at a distance of 1 m (3.3 ft) from the shipping containers. The dose rate at 1 m (3.3 ft) is about 0.14 mSv/hr (14 mrem/hr), so the dose per shipment is about 0.14 Sv (14 mrem). This is independent of the location of the advanced reactor site. Based on this conservative value, the annual doses to vehicle inspectors were calculated to be in the range of 9 to 18 mSv/yr (900 to 1800 mrem/yr), assuming the same person inspects all shipments of fuel and waste to and from the advanced reactor sites. The high end of the range is the ACR-700 and the low end is the surrogate AP1000. All of the values are less than the 20 mSv/yr (2000 mrem/yr) administrative control level on individual doses.

Resident

The analysis assumed that a resident lives 30 m (100 ft) from the point where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were extracted from RADTRAN 5 output files. These dose estimates are based on an individual located 30 m (100 ft) from the shipments that are traveling 24 km/hr (15 mph). The potential radiation doses to maximally exposed residents, which are independent of the location of the advanced reactor site, ranged from about 2.7×10^{-4} mSv/yr (2.7×10^{-2} mrem/yr) for the surrogate AP1000 to 5.5×10^{-4} mSv/yr (5.5×10^{-2} mrem/yr) for the ACR-700.

Individual Stuck in Traffic

This scenario addresses potential traffic interruptions that could lead to a person being exposed to a loaded shipment for 1 hour at a distance of 1.2 m (4 ft). The analysis assumed this exposure scenario would occur only one time to any individual. The dose to the MEI was calculated in DOE (2002) to be 0.016 mSv (1.6 mrem).

Person at a Truck Service Station

This scenario estimates doses to an employee at a service station where all truck shipments to/from the advanced reactors would stop. DOE (2002) assumed that this person is exposed for 49 minutes at a distance of 16 m (52 ft) from the loaded shipping container. This results in a dose of about 7 x 10^{-4} mSv/shipment (7 x 10^{-2} mrem/shipment) and an annual dose in the range from 0.044 mSv (4.4 mrem) for the surrogate AP1000 to 0.09 mSv/yr (9 mrem/yr) for the ACR-700.

6.2.1.2 Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of fuel to and from future reactors are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972), which forms the basis for Table S–4 of 10 CFR 51.52, because of improvements in highway safety and security and an expected decrease in traffic accident, injury, and fatality rates. There is no significant difference in the consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between advanced LWRs and current-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the impacts of accidents during transport of unirradiated fuel for advanced LWRs to the Exelon ESP site are expected to be smaller than the impacts listed in Table S–4 for current-generation LWRs.

With respect to the advanced gas-cooled reactors, accident rates (accidents per unit distance) and associated accident frequencies (accidents per year) would be expected to follow the same trends as for LWRs (i.e., overall reduction relative to the accident rates used in the WASH-1238 analysis). The consequences of accidents involving gas-cooled reactor unirradiated fuel, however, are more uncertain. The staff assumed that the gas-cooled reactor unirradiated fuel shipments would have the same abilities as LWR unirradiated fuel to maintain functional integrity following a traffic accident. This assumption is considered to be conservative because gas-cooled reactor fuel operates at significantly higher temperatures, and thus maintains integrity under more severe thermal conditions than LWR fuel. Detailed information about the behavior of the gas-cooled reactor fuel under impact conditions was not available. However, packaging systems for unirradiated gas-cooled reactor fuel will be required to meet the same performance requirements as unirradiated LWR fuel packages, including fissile material controls to prevent criticality during normal and accident condition. Consequently, it is expected that packaging systems for unirradiated gas-cooled reactor fuels would provide protection equivalent to those packages designed for unirradiated LWR fuels. In addition, the fuel forms for the gas-cooled reactors are similar to LWRs (i.e., UO_2 for the PBMR and uranium oxycarbide for the GT-MHR versus UO_2 for LWRs); thus, the inherent failure resistance provided by unirradiated gas-cooled reactor fuels should be similar to that provided by LWRs. Based on the assumption that unirradiated gas-cooled and LWR fuels and associated packaging systems would provide similar resistance to various environmental conditions, the staff concludes that the impacts of accidents involving unirradiated gas-cooled reactor fuel likely would not be significantly different than for unirradiated LWR fuel and would be within the impacts listed in Table S–4 for current-generation LWRs. However, these impacts are not considered to be resolved, and would need to be assessed at the CP or COL stage when specific information is available regarding other-than-LWR fuel performance, if the applicant references such designs.

6.2.2 Transportation of Spent Fuel

The staff performed an independent review of the environmental impacts of transporting spent fuel from the proposed new nuclear unit or units at the Exelon ESP site to a spent fuel disposal repository. The Yucca Mountain, Nevada, location is a possible location for a geologic repository. The staff considers an estimate of the impacts of the transportation of spent fuel to a possible repository at Yucca Mountain, Nevada, to be a reasonable bounding estimate of the transportation impacts to a storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distribution) along the shipping routes. Environmental impacts of normal operating conditions and transportation accidents are discussed in this section.

This analysis is based on the shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to the GEIS (NRC 1999). These assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1999).

Environmental impacts of transportation of spent fuel were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2003). Routing and population data used in the RADTRAN 5 code for truck shipments were obtained from the TRAGIS routing code (Johnson and Michelhaugh 2000). The population data in the TRAGIS code are based on the 2000 U.S. Census.

The staff's evaluation reviewed the impacts of spent fuel shipments originating from the Exelon ESP site and the alternative sites: Braidwood, Quad Cities, and Zion. Three other alternative sites (Byron, Dresden, and LaSalle) were considered by Exelon in its ER, but were not evaluated by the staff because the route characteristics of distance and population would not be significantly different to produce results different from the Braidwood, Quad Cities, and Zion sites. Appendix G provides the details of the analysis.

6.2.2.1 Normal Conditions

Normal conditions, sometimes referred to as “incident-free” transportation, are transportation activities in which shipments reach their destination without an accident occurring en route. Impacts from these shipments would be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses would occur to (1) persons residing along the transportation corridors between the Clinton ESP site and the proposed repository; (2) persons in vehicles traveling on the same route as a spent fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

Shipping casks have not been designed for the advanced reactor designs. Information in INEEL (2003) indicates that advanced LWR fuel designs would not be significantly different from existing LWR designs; therefore, the characteristics of current shipping cask designs were used for the analysis for advanced LWR designs. No information is available on spent fuel shipping cask designs for the gas-cooled reactors. For purposes of this Chapter 6 analysis, their design was assumed to be the same as those used for the existing LWRs. Spent fuel shipping cask designs for gas-cooled reactors have not been defined and, therefore, impacts are unresolved. Impacts would be evaluated at the CP or COL stage if the applicant references such designs.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 1 m (3 ft) from the vehicle, packaging dimensions, number of persons in the truck crew, stop time, and population density at stops. For a listing of the values for these and other parameters, refer to Appendix G. Table 6-6 presents radiation dose estimates to the transport workers and the public for the primary and alternative ESP sites. Doses are presented on a per-shipment basis. The per-shipment dose estimates are independent of reactor technology because they were calculated based on an assumed external radiation dose rate emitted from the cask, which was fixed at the regulatory maximum limit for the advanced reactor designs (i.e., 0.1 mSv/hr [10 mrem/hr] at 2 m [7 ft]).

Population dose estimates per reference reactor year are presented in Table 6-7 for specific advanced reactor designs. Population doses were calculated by multiplying the number of spent fuel shipments per year for each advanced reactor design times the dose per shipment from Table 6-6. Population doses were normalized to the reference LWR design in WASH-1238 (880 net MW(e)) (AEC 1972). This corresponds to an 1100-MW(e) LWR operating at 80-percent capacity. Appendix G provides the basis upon which the number of spent fuel shipments was derived for each advanced reactor design.

Table 6-6. Routine (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from Potential ESP Sites to a Spent Fuel Disposal Facility

	Population Dose, person-Sv/shipment[(a)]		
ESP Site	**Crew**	**Onlookers**	**Along Route**
Clinton	7.2×10^{-4}	2.5×10^{-3}	4.5×10^{-5}
Braidwood	7.1×10^{-4}	2.4×10^{-3}	4.4×10^{-5}
Quad Cities	6.7×10^{-4}	2.1×10^{-3}	4.1×10^{-5}
Zion	7.3×10^{-4}	2.5×10^{-3}	5.2×10^{-5}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

The bounding cumulative doses to the exposed population given in Table S–4 (10 CFR 51.52(c)) are

- 0.04 person-Sv (4 person-rem) per reference reactor year to transport workers
- 0.03 person-Sv (3 person-rem) per reference reactor year to general public (onlookers) and members of the public along the route.

Population doses to the crew for the ACR-700 and the onlookers for the ABWR, ESBWR, AP1000, ACR-700, IRIS, and GT-MHR, exceed Table S–4 values. Two key reasons for the higher population doses compared to Table S–4 are the higher number of spent fuel shipments estimated for some of the reactor technologies and the longer shipping distances assumed for the analyses (i.e., to a possible repository in Nevada) than were used in WASH-1238. WASH-1238 used a “typical” distance for a spent fuel shipment of 1600 km (1000 mi), whereas the shipping distances used in this assessment ranged from about 3000 km (1800 mi) to 4700 km (2900 mi). The higher numbers of shipments are based on spent fuel shipping casks designed to transport shorter-cooled fuel (i.e., 150 days out of the reactor). It was assumed in this analysis that the shipping cask capacities are 0.5 MTU/shipment, roughly equivalent to one PWR or two BWR spent fuel assemblies per shipment.

Newer shipping cask designs are based on longer-cooled spent fuel (i.e., 5 years out of reactor) and have larger capacities than those used in this assessment. DOE (2002) spent fuel shipping cask capacities were approximately 1.8 MTU/shipment, or up to four PWR or nine BWR fuel assemblies per shipment. Use of the newer shipping cask designs will reduce the number of spent fuel shipments and the associated environmental impacts. On balance, if the population doses are adjusted for the shipping distance and shipping cask capacity, the routine population

Table 6-7. Routine (Incident-Free) Population Doses from Spent Fuel Transportation, Normalized to Reference LWR

Reactor Type	Reference LWR (WASH-1238)			ABWR/ESBWR			AP1000			ACR-700		
Shipments per Year	60			41			40			90		
	Environmental Effects, person-Sv[(a)] per reference reactor-year											
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Clinton	0.04	0.15	0.0027	0.03	0.1	0.0018	0.028	0.097	0.0018	0.064	0.22	0.0041
Braidwood	0.04	0.15	0.0026	0.03	0.1	0.0018	0.028	0.097	0.0017	0.063	0.22	0.0039
Quad Cities	0.04	0.13	0.0024	0.027	0.09	0.0017	0.026	0.084	0.0016	0.06	0.19	0.0036
Zion	0.044	0.15	0.0031	0.03	0.1	0.0021	0.029	0.097	0.002	0.065	0.22	0.0046

Reactor Type	IRIS			GT-MHR			PBMR		
Shipments per Year	35			34			12		
	Environmental Effects, person-Sv[(a)] per reference reactor year								
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Clinton	0.025	0.085	0.0016	0.024	0.082	0.0015	0.008	0.028	0.00051
Braidwood	0.025	0.085	0.0015	0.024	0.082	0.0015	0.0079	0.027	0.00049
Quad Cities	0.023	0.074	0.0014	0.022	0.071	0.0014	0.0075	0.024	0.00046
Zion	0.025	0.085	0.0018	0.024	0.082	0.0017	0.0082	0.028	0.00058

(a) To convert person-Sv to person-rem, multiply by 100.

doses from spent fuel shipments from all reactor types and all sites fall within Table S–4 requirements.

Other conservative assumptions in the staff's calculation include the following:

- Use of the regulatory maximum dose rate (0.1 mSv/hr [10 mrem/hr] at 2 m) in the RADTRAN 5 calculations. The shipping casks assumed in the EIS prepared in support of the application for a geologic repository at the proposed Yucca Mountain site (DOE 2002) were designed to transport spent fuel that has cooled for 5 years. In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. Sprung et al. (2000) developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository will have dose rates less than half of the regulatory limit. Consequently, the estimated population doses in Table 6-7 could be divided in half if more realistic dose rate projections are used.

- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are short-duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Furthermore, empirical data provided in Griego et al. (1996) indicate that a 30-minute stop is toward the high end of the stop-time distribution. Average stop times observed by Griego et al. (1996) are on the order of 18 minutes. Based on these observations, it was concluded that the stop model assumptions used in this study overestimate public doses at stops by at least a factor of 2. Consequently, the doses to onlookers given in Table 6-7 could be reduced by a factor of 2 to reflect more realistic truck shipping conditions.

Exelon performed its own RADTRAN 5 calculations looking at the impact of “incident-free” transport of spent fuel to a spent fuel disposal facility. The assumed transport of spent fuel originated from the Maine Yankee Nuclear Plant (a distance farther than the Clinton site) and terminated at a disposal facility assumed to be at Yucca Mountain, Nevada. Dose estimates per shipment were similar to those calculated by the staff.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response model. This theory states that any increase in dose, no matter how small, results in an incremental increase in health risk. NRC accepts this theory as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from ICRP Publication 60 (ICRP 1991). All the population doses presented in Table 6-7 are less than 1 person-Sv/yr (100 person-rem/yr); therefore, the total detriment estimates associated with these population doses would all be less than 1 x 10^{-1} fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would be expected to occur annually in the same population from exposure to natural sources of radiation.

Dose estimates to the MEI from the transport of unirradiated fuel, spent fuel, and waste under normal conditions are presented in Section 6.2.1.1.

6.2.2.2 Accidents

As discussed previously, the staff used the RADTRAN 5 computer code to estimate impacts of transportation accidents involving spent fuel shipments. RADTRAN 5 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (e.g., “fender benders”) to those with low frequencies and high consequences (e.g., accidents in which the shipping container is exposed to severe mechanical and thermal conditions). Details of the analysis are discussed in Appendix G.

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were from *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003). This report included hundreds of radionuclides for each advanced reactor type. A screening analysis was conducted to select the dominant contributors to accident risks to simplify the RADTRAN 5 calculations. The screening identified the radionuclides that would contribute more than 99.999 percent of the dose from inhalation of radionuclides released following a transportation accident. The dominant radionuclides are similar regardless of the fuel type (i.e., advanced LWR fuel or gas-cooled reactor fuel). Spent fuel inventories used in the staff analysis are presented in Table 6-8. The list of radionuclides provided in the table includes all of the radionuclides that were included in the analysis conducted by Sprung et al. (2000), which validates the screening process used in this EIS. Also note that the INEEL (2003) analysis relied upon by Exelon in its application did not provide radionuclide source terms for radioactive material deposited on the

Table 6-8. Radionuclide Inventories Used in Transportation Accident Risk Calculations for Each Advanced Reactor Type, Bq/MTU[(a)]

Radionuclide	ABWR/ESBWR	AP1000	GT-MHR	PBMR
Am-241	4.96×10^{13}	2.69×10^{13}	8.18×10^{13}	7.55×10^{13}
Am-242m	1.24×10^{12}	4.85×10^{11}	5.03×10^{11}	8.51×10^{11}
Am-243	1.20×10^{12}	1.24×10^{12}	5.14×10^{11}	4.77×10^{12}
Ce-144	4.22×10^{14}	3.28×10^{14}	2.15×10^{15}	1.19×10^{15}
Cm-242	2.04×10^{12}	1.05×10^{12}	1.51×10^{12}	2.78×10^{12}
Cm-243	1.37×10^{12}	1.14×10^{12}	2.02×10^{11}	1.96×10^{12}
Cm-244	1.80×10^{14}	2.87×10^{14}	2.83×10^{13}	5.48×10^{14}
Cm-245	2.43×10^{10}	4.48×10^{10}	1.65×10^{8}	5.29×10^{10}
Co-60	1.01×10^{14}	(b)	(b)	(b)
Cs-134	1.78×10^{15}	1.78×10^{15}	2.21×10^{15}	4.03×10^{15}
Cs-137	4.59×10^{15}	3.44×10^{15}	1.08×10^{16}	1.41×10^{16}
Eu-154	3.81×10^{14}	3.38×10^{14}	3.23×10^{14}	3.74×10^{14}
Eu-155	1.93×10^{14}	1.71×10^{14}	8.77×10^{13}	1.08×10^{14}
Pm-147	1.25×10^{15}	6.51×10^{14}	6.92×10^{15}	5.07×10^{15}
Pu-238	2.27×10^{14}	2.25×10^{14}	1.17×10^{14}	4.55×10^{14}
Pu-239	1.43×10^{13}	9.44×10^{12}	2.25×10^{13}	1.11×10^{13}
Pu-240	2.28×10^{13}	2.01×10^{13}	3.96×10^{13}	3.32×10^{13}
Pu-241	4.51×10^{15}	2.58×10^{15}	8.33×10^{15}	7.18×10^{15}
Pu-242	8.29×10^{10}	6.73×10^{10}	1.56×10^{11}	4.51×10^{11}
Ru-106	6.07×10^{14}	5.74×10^{14}	1.48×10^{15}	1.68×10^{15}
Sb-125	1.99×10^{14}	1.42×10^{14}	2.21×10^{14}	2.51×10^{14}
Sr-90	3.27×10^{15}	2.29×10^{15}	8.95×10^{15}	1.08×10^{16}
Y-90	3.27×10^{15}	2.29×10^{15}	8.95×10^{15}	1.08×10^{16}

(a) To convert Bq/MTU to Ci/MTU, divide the value by 3.7×10^{10}.
(b) Cobalt-60 is an activation product. Only the ABWR/ESBWR submittal in INEEL (2003) provided inventory data for activation products.

external surfaces of LWR spent fuel rods (commonly called "crud"). In addition, data on activation products were provided only for the advanced BWR. The advanced BWR spent fuel transportation risks were calculated assuming that the entire cobalt-60 inventory is in the form of crud. This is very conservative as the source term used here is about 2 orders of magnitude greater than that given in Sprung et al. (2000). Because crud is deposited from corrosion products generated elsewhere in the reactor cooling system and the complete reactor design and operating parameters are uncertain, the quantities and characteristics of crud deposited on advanced reactor spent fuel are unknown at this time. Consequently, the impacts of crud and activation products on spent fuel transportation accident risks will need to be examined at the CP/COL stage.

INEEL (2003) did not provide radionuclide inventory data for the ACR-700 and IRIS advanced reactors. Because transportation accident risks were not quantified for these reactor types, these accident risks are unresolved and would need to be assessed at the CP or COL stage if the applicant references either of these designs.

Robust shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe postulated accident conditions with essentially no loss of containment or shielding capability. These casks are also designed with fissile material controls to ensure that the spent fuel remains subcritical under normal and accident conditions. According to Sprung et al. (2000), the likelihood of encountering accident conditions that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The staff assumed that shipping casks for advanced reactor spent fuels will provide equivalent mechanical and thermal protection of the spent fuel cargo.

The RADTRAN 5 accident risk calculations were performed using unit radionuclide inventories (Bq/MTU) for the spent fuel shipments from the various reactor types. The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from each potential advanced reactor site. As was done for routine exposures, the staff assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities.

For this assessment, release fractions for current-generation LWR fuels were used to approximate the impacts from the advanced reactor spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions. Because of the lack of experimental data on gas-cooled reactor fuels, it is currently not known if this approach is bounding. However, gas-cooled reactors operate at much higher temperatures than LWRs; therefore, high-temperature conditions anticipated in transportation accident fires should have less of an effect on radionuclide releases than they do for LWR fuels. Thus, smaller release fractions are anticipated for advanced gas-cooled reactor fuels than for LWR fuels subjected to thermal transients. However, this issue is unresolved because of the lack of information on gas-cooled reactor designs.

The NRC staff used RADTRAN 5 to calculate the population dose from the radioactive material released to the environment for four of five possible exposure pathways.[(a)] These pathways are:

- External dose from exposure to the passing cloud of radioactive material

- External dose from the radionuclides deposited on the ground by the passing plume (groundshine). The staff's analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway.

- Internal dose from inhalation of airborne radioactive contaminants (inhalation).

- Internal dose from resuspension of radioactive materials that were deposited on the ground (resuspension). The staff's analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures.

Table 6-9 presents the environmental consequences of transportation accidents when shipping spent fuel from the Clinton ESP site and alternative sites to the proposed Yucca Mountain, repository. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (for details, see Appendix G). Table 6-9 presents estimates of population dose (person-Sv/reference reactor year) for several of the advanced reactor designs. These values are normalized to the WASH-1238 reference reactor (880-MW(e) net electrical generation, 1100-MW(e) reactor operating at 80-percent capacity) (AEC 1972).

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the

(a) Internal dose from ingestion of contaminated food was not considered, as the staff assumed evacuation and subsequent interdiction of foodstuffs following a potential transportation accident.

Table 6-9. Annual Spent Fuel Transportation Accident Impacts for Advanced Reactors, Normalized to Reference 1000-MW(e) LWR Net Electrical Generation

	Advanced Reactor Type			
	ABWR/ESBWR	**AP1000**	**GT-MHR**	**PBMR**
MTU/yr	**20.3**	**19.7**	**6**	**5.8**
Population dose, person-Sv per reference reactor year[(a)]				
Clinton	2.3×10^{-6}	2.0×10^{-7}	9.1×10^{-8}	1.5×10^{-7}
Braidwood	2.1×10^{-6}	2.0×10^{-7}	8.9×10^{-8}	1.5×10^{-7}
Quad Cities	2.1×10^{-6}	1.8×10^{-7}	8.4×10^{-8}	8.1×10^{-8}
Zion	3.0×10^{-6}	2.7×10^{-7}	1.2×10^{-7}	2.0×10^{-7}

(a) Multiply person-Sv/yr times 100 to obtain person-rem/yr.

National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose respense model. This theory states that any increase in dose, no matter how small, results in an incremental increase in health risk. NRC accepts this theory as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from ICRP Publication 60 (ICRP 1991). All the population doses presented in Table 6-9 are less than 1×10^{-5} person-Sv/yr (1×10^{-3} person-rem/yr); therefore, the total detriment estimates associated with these population doses would all be less than 1×10^{-6} fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are quite small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would be expected to occur annually in the same population from exposure to natural sources of radiation.

6.2.2.3 Conclusion

The values determined by this analysis represent the contribution of such effects to the environmental costs of licensing the reactor. Because of the conservative approaches and data used to calculate doses, actual environmental effects are not likely to exceed those calculated in the EIS. Thus, the staff concludes that the overall transportation accident risks associated with advanced reactor spent fuel shipments are likely to be SMALL and are consistent with the risks associated with transportation of spent fuel from current-generation reactors presented in Table S–4 of 10 CFR 51.52. The fuel performance characteristics, shipping casks, and accident risks for other-than-LWR designs are unresolved and would need to be assessed at the CP or COL stage if the applicant references such designs.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting waste from advanced reactor sites. The conditions listed in 10 CFR 51.52(a) that apply to shipments of radioactive waste are as follows:

- Radioactive waste (except spent fuel) is packaged in solid form.
- Radioactive waste (except spent fuel) is shipped from the reactor by truck or rail.
- The weight limitation is 33,100 kg (73,000 lb) per truck and 100 tons per cask per railcar.
- The traffic density limitation is less than one truck shipment per day or three railcars per month.

In INEEL (2003), it is stated that all the radioactive waste will be transported by truck. Exelon plans to solidify and package its waste regardless of which advanced reactor technology it chooses. In addition, waste from any of the advanced reactor technologies will be subject to NRC (10 CFR Part 71) and DOT (49 CFR Parts 171, 172, 173, and 178) regulations for the shipment of radioactive material. Radioactive waste from any of the advanced reactor technologies is expected to be capable of being shipped in compliance with Federal or state weight restrictions.

Table 6-10 presents estimates of annual waste volumes and annual waste shipment numbers for the advanced reactor types normalized to the reference 1100-MW(e) LWR defined in WASH-1238 (AEC 1972). Annual waste volumes and waste shipments for the advanced reactor technologies were less than those for the 1100-MW(e) reference reactor, which was the basis for Table S–4 for all designs except the PBMR.

As shown in the table, only the PBMR would be expected to generate a larger volume of radioactive waste than the reference LWR in WASH-1238 (AEC 1972). However, the GT-MHR and PBMR information in INEEL (2003) assumed that the applicant would ship wastes using two different packaging systems: one that hauls 28.3 m^3 per shipment (1000 ft^3 per shipment) and one that hauls 5.7 m^3 per shipment (200 ft^3 per shipment). Under those conditions, the number of shipments of radioactive waste per year, normalized to 1100 MW(e) generation capacity, would be about six shipments per year per 1100 MW(e) (880 net MW(e)) for the GT-MHR and seven shipments per year per 1100 MW(e) for the PBMR. These estimates are well below the reference LWR (46 shipments per year per 1100 MW(e)). However, impacts from gas-cooled reactor designs are unresolved because of the lack of verifiable information.

Table 6-10. Summary of Radioactive Waste Shipments for Advanced Reactors

Reactor Type	INEEL (2003) Waste Generation Information	Annual Waste Volume, m^3/yr per unit	Electrical Output, MW(e) per unit	Normalized Rate, m^3/1100 MW(e) (880 MW(e) net)[(a)]	Shipments/ 1100 MW(e) (880 MW(e) net) Electrical Output[(b)]
Reference LWR (WASH-1238)	100 m^3/yr per unit	108	1100	108	46
ABWR	100 m^3/yr per unit	100	1500	62	27
ESBWR	100 m^3/yr per unit	100	1500	62	27
AP1000	55 m^3/yr per unit	110 (2 units)	2300[(c)]	45	20
ACR-700	47.5 m^3/yr per unit	95 (2 units)	1462[(d)]	64	28
IRIS	25 m^3/yr per unit	75 (3 units)	1005[(e)]	67	29
GT-MHR	98 m^3/yr (4 unit facility)	98 (4 units)	1140[(f)]	86	37[(h)]
PBMR	100 drums/yr per unit	168 (8 units)	1320[(g)]	118	51[(h)]

Conversions: 1 m^3 = 35.31 ft^3. Drum volume = 210 liters (0.21 m^3).

(a) Capacity factors used to normalize the waste generation rates to an equivalent electrical generation output are given in Table 6-3 for each reactor type. All are normalized to 880-MW(e) net electrical output (1100-MW(e) plant with an 80-percent capacity factor).

(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m^3/shipment (108 m^3/yr divided by 46 shipments/yr).

(c) The AP1000 site includes two reactors at 1150 MW(e) per reactor.

(d) The ACR-700 site includes two reactors at 731 MW(e) per reactor.

(e) The IRIS site includes three reactors at 335 MW(e) per reactor.

(f) The GT-MHR site includes four reactors at 285 MW(e) per reactor.

(g) The PBMR site includes eight reactors at 165 MW(e) per reactor.

(h) The applicant states in INEEL (2003) that 90 percent of the waste could be shipped on trucks carrying 28 m^3 (1000 ft^3) of waste and the remaining 10 percent in shipments carrying 5.7 m^3 (200 ft^3) of radioactive waste. This would result in five to six shipments per year after normalization to the reference LWR electrical output.

The sum of the daily shipments of unirradiated fuel, spent fuel, and radioactive waste is well below the one truck shipment per day condition given in 10 CFR 51.52, Table S–4 for all reactor types. Doubling the shipment estimates to account for empty return shipments is still well below the one-shipment-per-day condition.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and waste under normal conditions are presented in Section 6.2.1.1.

6.2.4 Conclusions

An analysis was conducted of the impacts of transporting unirradiated fuel to advanced reactor sites and spent fuel and wastes from advanced reactor sites to disposal facilities under normal operating and accident conditions. To make comparisons to Table S–4, the environmental impacts are normalized to a reference reactor year. The reference reactor is an 1100-MW(e) reactor that has an 80-percent capacity factor, for a total electrical output of 880 MW(e) per year. The environmental impacts can be adjusted to calculate impacts per site by multiplying the normalized impacts by the ratio of the total electric output for the advanced reactor sites to the electric output of the reference reactor.

Because of the conservative approaches and data used to calculate doses, actual environmental effects are not likely to exceed those calculated in the EIS. Thus, the staff concludes that the environmental impacts of transportation of fuel and radioactive wastes to and from advanced LWR designs would be SMALL and would be consistent with the risks associated with transportation of fuel and radioactive wastes from current-generation reactors presented in Table S–4 of 10 CFR 51.52. For gas-cooled designs, the impacts are likely to be small, but this issue is unresolved because of the lack of verifiable information on these designs. At the CP or COL stage, an applicant referencing these designs would need to be provided the necessary data and the staff would need to validate the assumptions used in this transportation analysis.

Assumptions that will need validation if a gas-cooled reactor is selected include the following:

- Verifying that unirradiated and spent fuel from gas-cooled reactors have the same abilities as LWR unirradiated and spent fuel to maintain fuel and cladding integrity following a traffic accident

- Verifying that shipping cask design assumptions (for example, cask capacities) are equal to or bounded by the assumptions in this analysis

- Verifying that unirradiated fuel initial core/refueling requirement, spent fuel generation rates, and radioactive waste generation rate assumptions are equal to or bounded by the assumptions in this analysis

- Verifying that shipping cask capacities and accident source terms, including spent fuel inventories, severity fractions, and release fractions, are equal to or bounded by the assumptions in this analysis.

Should the ACR-700 or IRIS reactors be chosen for the ESP site, a transportation accident analysis will be performed because spent fuel inventories were not available for this analysis.

6.3 Decommissioning Impacts

At the end of the operating life of a power reactor, the NRC regulations require that the facility undergo decommissioning. Decommissioning is the removal of a facility safely from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.82, 50.75, and 50.82.

Environmental impacts from the activities associated with the decommissioning of any LWR before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002). If an applicant for a CP or COL referencing the Exelon ESP applies for a license to operate a new nuclear unit at the ESP site, there is a requirement to provide a report containing a certification that financial assurance for radiological decommissioning will be provided. At the time an application is submitted, the requirements in 10 CFR 50.33, 50.75, and 52.77 (and any other applicable requirements) will have to be met.

At the ESP stage, applicants are not required to submit information regarding the process of decommissioning, such as the method chosen for decommissioning, the schedule, or any other aspect of planning for decommissioning. Exelon did not provide this information in its application. The regulatory requirements on decommissioning activities are expected to limit the impacts of decommissioning to a SMALL impact. For the new nuclear unit, if LWR designs are chosen or if gas-cooled reactors that were considered in NUREG-0586, Supplement 1 (NRC 2002) are chosen, the impacts from decommissioning are expected to be within the bounds described in NUREG-0586, Supplement 1. In such cases, the staff expects the impact from decommissioning is likely to be SMALL. However, for whatever design that is selected, the impacts from decommissioning are unresolved and would have to be assessed at the CP or COL stage.

6.4 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, “Standards for Protection Against Radiation.”

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, “Domestic Licensing of Production and Utilization Facilities.”

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy*, Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

49 CFR Part 171. Code of Federal Regulations, Title 49, *Transportation*, Part 171, "General Information, Regulations, Definitions."

49 CFR Part 172. Code of Federal Regulations, Title 49, *Transportation*, Part 172, "Hazardous Materials Table, Special Provisions."

49 CFR Part 173. Code of Federal Regulations, Title 49, *Transportation*, Part 173, "Shippers - General Requirements for Shipments and Packaging."

49 CFR Part 178. Code of Federal Regulations, Title 49, *Transportation*, Part 178, "Specifications for Packaging."

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7.0 Cumulative Impacts

When evaluating the potential impacts of construction and operation of a new nuclear unit at the site proposed by Exelon Generation Company, LLC (Exelon) in the early site permit (ESP) application, the staff considered potential cumulative impacts that fall within the plant parameter envelope. For purposes of this analysis, past actions are those related to the existing Clinton Power Station (CPS) Unit 1. Present actions are those related to resources at the time of the ESP application until the start of construction. Future actions are those that are reasonably foreseeable through construction and operation of the proposed ESP unit, including decommissioning. The geographical area over which past, present, and future actions could contribute to cumulative impacts is dependent on the type of action considered and is described below for each impact area.

The environmental impacts of the alternatives are evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B. The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a] with the additional impact category of environmental justice.

The impacts of the proposed action, as described in Chapters 4 and 5, are combined with other past, present, and reasonably foreseeable future actions in the vicinity of the CPS site that would affect the same resources impacted by CPS Unit 1, 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. For issues considered to be resolved, the staff will verify the continued applicability of all assumptions should an applicant for a construction permit (CP) or a combined license (COL) reference the Exelon ESP.

For some issues related to the construction and operation of a proposed ESP nuclear unit, there was not sufficient information to allow the staff to evaluate the impacts. These issues are

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

unresolved and an evaluation of cumulative impacts for these issues cannot be completed until additional information is provided by an applicant for a CP or COL that references an ESP for the Exelon ESP site.

7.1 Land Use

For purposes of this analysis, the geographic area considered for cumulative impacts to land use resulting from construction and operation of a new nuclear unit encompasses DeWitt County, Illinois.

The staff reviewed the available information on the land-use impacts of constructing an additional nuclear unit at the Exelon ESP site. DeWitt County has developed a comprehensive plan, which includes zoning specifications and other land-use considerations. The cumulative impacts for land use include possible additional growth and land conversions to accommodate new workers and services. However, these impacts would be SMALL as the construction workforce and the operations workforce would be drawn from an area much wider than DeWitt County to include the large cities of Bloomington-Normal, Champaign-Urbana, and Decatur. Because the workforce would be diffused over these larger cities in the labor supply region, induced land-use impacts resulting from either construction or operation of a new nuclear unit at the Exelon ESP site would not be likely. Property tax revenue from a new nuclear unit might also increase infrastructure improvements in DeWitt County generally and the City of Clinton specifically. Based on the information provided by Exelon and the staff's independent review, the staff concludes that, while lower tax rates or better services might encourage development, the comprehensive plan would control development in DeWitt County. Based on Section 4.1.2, the one-time upgrading of the existing transmission system or construction of a new transmission system would be expected to have only minimal impact on land use and would not be expected to cause any cumulative impacts. Therefore, the staff concludes that the cumulative land-use impacts would be SMALL, and mitigation would not be warranted.

7.2 Air Quality

The Exelon ESP site is located in an area that is in attainment for criteria pollutants. In addition, the State regulates any emissions to the atmosphere. The air-quality impacts of construction and operations are estimated to be small. No other significant impacts from other actions were identified. Based on its evaluation, the staff concludes that the cumulative impacts of air quality would be SMALL and that mitigation would not be warranted.

7.3 Water Use and Quality

The staff, while preparing this assessment, did not identify any other industrial, commercial, or public installations that would be located in the general vicinity of the Exelon ESP site before the end of the proposed Exelon unit operations. The intake of water from, and the discharge of water to, Clinton Lake from a new nuclear unit would be regulated by the Illinois Environmental Protection Agency (IEPA), just as the existing CPS unit is presently regulated by the IEPA. The intake and discharge limits for each installation are set by considering the overall or cumulative impact of all of the other regulated activities in the area. Compliance with the permits issued under the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) minimizes the cumulative effects on aquatic resources. Operation of a new nuclear unit would require discharge permits from IEPA, which would address changing requirements so that cumulative water-quality objectives are served. Therefore, the staff concludes that the potential cumulative water impacts of construction and operation of a new nuclear unit at the ESP site would be SMALL. The staff concludes that in normal years the potential cumulative water impacts of operation of a new unit would be SMALL. However, the staff also concludes that in dry years, the potential cumulative water impacts of operation of a new unit would be MODERATE.

7.4 Terrestrial Ecosystem

The impacts from construction and operation of a new nuclear unit at the Exelon ESP site were evaluated to determine the magnitude of their contribution to regional cumulative adverse impacts to terrestrial ecological resources. Determinations for construction were made for the important terrestrial species (animal and plant) and habitats (as defined in NRC 2000) by evaluating construction effects in light of other past, present, and future actions in the region. Determinations for operation were made by considering resource attributes normally affected by cooling tower operation and transmission line operation and right-of-way maintenance and by evaluating effects in light of other past, present, and future actions in the region. For this analysis, the geographic region encompassing past, present, and foreseeable future actions includes the area around the ESP site, the existing CPS transmission line rights-of-way, and Clinton Lake.

The area around the ESP site, transmission line rights-of-way, and Clinton Lake currently consists mostly of agricultural fields and pasture. This area incurred major losses of prairie species and habitats during agricultural conversion. Construction of a new nuclear unit at the ESP site would occur in areas that were previously disturbed for the CPS and now consist mostly of early successional plant species and a small amount (about 1.4 ha [3.5 ac]) of forest habitat. Construction is anticipated not to adversely affect the four minor wetlands (less than

0.4 ha [1 ac] each) onsite. Finally, construction of a new nuclear unit likely would not destroy or displace any important terrestrial species or habitats onsite, because none (except for the four minor wetlands noted above) is currently known to occur on or within 16 km (10 mi) of the ESP site.

In addition, an undetermined amount of wildlife habitat, including any areas set aside for wildlife conservation (e.g., State wildlife areas) and relatively uncommon habitats (e.g., forest, prairie, wetlands, etc.) important to wildlife and/or to Federally protected species (e.g., Indiana bat [*Myotis sodalis*] [see Section 4.4.3]), could be disturbed by construction for transmission system upgrades (see Section 4.4.1.1). If construction for the addition of new transmission lines occurred entirely within or required expansion of the existing rights-of-way (see Section 4.4.1.1), the overall contribution of construction of the proposed ESP unit to cumulative losses of important species and habitats in the region would be minor. However, if construction for the addition of new transmission lines required creation of one or more new rights-of-way (see Section 4.4.1.1), the overall contribution of construction of the proposed ESP unit to cumulative losses of important species and habitats in the region could range from minor to extensive. During the review for the ESP site, the staff did not identify any other present or future actions in the region that could significantly impact terrestrial species or habitats.

During the review for the ESP site, the staff did not identify any other past, present, or future actions in the region that could significantly affect wildlife and wildlife habitat in ways similar to those associated with cooling operation of a new nuclear unit (i.e., cooling tower noise, exposure of Clinton Lake shoreline habitat due to cooling tower drawdown of the lake, adverse effects on crops and ornamental vegetation and native plants from cooling tower salt drift, and birds via collisions with cooling towers). Thus, because these types of impacts were considered negligible for the new nuclear unit (see Section 5.4.1), cumulative adverse impacts of these types in the region would also be considered minor.

During the review for the ESP site, the staff did not identify any other past, present, or future actions in the region that could significantly affect wildlife and wildlife habitat in ways similar to those associated with transmission line operation and right-of-way maintenance for a new nuclear unit (i.e., birds via collisions with transmission lines, flora and fauna [plants, agricultural crops, honeybees, wildlife, livestock] from electromagnetic fields and right-of-way maintenance, and floodplains and wetlands via right-of-way maintenance). Thus, because these types of impacts were considered negligible for a new nuclear unit (see Section 5.4.1), cumulative adverse impacts of these types in the region would also be considered minor.

In summary, Exelon anticipates the addition of new transmission lines to upgrade the existing transmission system, but has not initiated selection of one or more transmission-system routes at this time. The actual need for and nature of transmission-system upgrades and the magnitude of associated construction impacts to terrestrial ecosystems would be evaluated by the transmission and distribution system owner and operator under the regulatory process described in Section 4.4.1.1 prior to or during the CP or COL phase. Therefore, the staff concludes that the contribution of construction of the ESP unit to cumulative impacts on terrestrial ecological resources in the region is unresolved. The staff also concludes that the contribution of operations (including cooling tower operation, operation of the upgraded transmission system, and maintenance of the associated transmission line rights-of-way) and eventual decommissioning of the unit to cumulative impacts on terrestrial ecological resources in the region would be SMALL, and additional mitigation would not be warranted.

7.5 Aquatic Ecosystem

The staff evaluated construction and operation of a new nuclear unit at the Exelon ESP site to determine the magnitude of their contribution to regional cumulative adverse impacts to aquatic ecological resources. Determinations for construction were made for the generic categories of important aquatic species (animal and plant) and habitats (as defined by NRC 2000) by evaluating construction effects in light of other past, present, and future actions in the region. Determinations for operation were made for resource attributes normally affected by the cooling water system. This includes an evaluation of potential effects of water intake, consumption, and discharge in light of other past, present, and future actions in the region. For this analysis, the geographic region encompassing past, present, and foreseeable future actions includes Clinton Lake and Salt Creek immediately downstream of the Clinton Lake Dam.

From an aquatic ecological perspective, the construction of the CPS in the late 1970s converted what was once rural land and approximately 24 ha (60 ac) of flowing water at the confluence of Salt Creek and the North Fork Salt Creek to a 1981-ha (4895-ac) reservoir (AEC 1974). The Clinton Lake Dam moderated the flow to Salt Creek, decreasing the natural wide variation in stream temperatures, flows, and water levels. Thus, the site has already experienced a dramatic change in habitat type and species composition.

Since the filling of Clinton Lake, some aquatic organisms have disappeared or have been displaced while others have been favored by the lake conditions. Clinton Lake currently supports a variety of species common to other Illinois lakes and reservoirs. There is a strong sport fishery supported and managed by the Illinois Department of National Resources, although there are no commercial fisheries in the vicinity of the ESP site. There are no Federally or State-listed threatened or endangered aquatic species found in Clinton Lake or immediately downstream in Salt Creek. During its review of the Exelon ESP site, the staff did not identify any other present or future actions in the region that could significantly alter aquatic species or habitats. Construction of a new nuclear unit at the ESP site would occur in areas that have been previously disturbed at CPS. Impacts to aquatic organisms would primarily be associated with construction of a new cooling water intake structure adjacent to the existing CPS intake structure. Benthic macroinvertebrates and nearshore habitat would be lost as a result of dredging, dewatering, and other construction activities; however, the amount of open water, shoreline, benthic habitat, and benthic fauna that would be lost is a small fraction of the total found at Clinton Lake (Exelon 2006). Fish and other mobile aquatic organisms might be temporarily displaced due to water displacement at the construction site, machinery noise, increased turbidity, and boating activities, but would be expected to return to the area once construction was complete. Therefore, the staff concludes that the contribution of construction impacts of a new nuclear unit at the Exelon ESP site to cumulative losses of important species and habits in the region would be SMALL.

The staff considered potential cumulative effects of impacts related to water consumption and to impingement and entrainment of aquatic organisms. Past and present records indicate that water consumption (and discharge) of the existing CPS once-through unit is approximately 35,700 L/s (566,000 gpm) in summer and 28,100 L/s (445,000 gpm) in winter. This is well within the current NPDES permitted discharge limit of 42,300 L/s (670,000 gpm). Entrainment data are not available for the CPS although the recreationally important fish species are not considered to be highly susceptible to entrainment based on their general spawning habitat preferences for shallow littoral zones, which are not associated with the deeper water at the cooling water intake structure (Lutterbie 2002). Previous impingement studies indicate that gizzard shad *(Dorosoma cepedianum)* make up approximately 99 percent of the total number of fish and biomass impinged on the intake screens at CPS (Pallo 1988). While the number of fish impinged is large, the abundance of gizzard shad has been consistently high since operation of the CPS began, indicating that there are no apparent adverse impacts to the population as a result of current cooling water intake withdrawals related to operation of the CPS.

Exelon has stated that it would operate the new ESP unit within the limits of the current NPDES permit for CPS. An estimated 6564 L/s (104,000 gpm) in summer and 14,200 L/s (225,000 gpm) in winter would be available for withdrawal by a new nuclear unit under the existing NPDES permit (Exelon 2006). Water-use requirements estimated for a new nuclear unit under the cooling options being considered are well below 6564 L/s (104,000 gpm) (Exelon 2006). Although a full review of anticipated impacts due to impingement and entrainment cannot be performed without a specific cooling water intake design, the relatively low water consumption estimated for a new nuclear unit intake would keep impingement and entrainment low, and compliance with U.S. Environmental Protection Agency regulations for new intake structures would protect aquatic organisms (see Section 5.4.2.1) (66 FR 65255). The regulations require intake structures to meet best available technology standards for new and existing cooling water intake structures, through design and construction technologies, operational measures, or restoration measures. The adoption of these performance standards would make it likely that cumulative impacts from operation of two independent cooling water intake systems on Clinton Lake would not affect the maintenance of a balanced, indigenous population of fish, shellfish, and other aquatic organisms, and impacts would be SMALL. However, the intake structure design and permit requirements that would be set by IEPA are unknown at this time. The impact could be MODERATE if best available technology is not utilized at the CPS and localized reduction of fish occurs, beyond what natural recruitment can replace, as a result of joint operation of the CPS and the ESP unit.

The staff also considered the potential cumulative effects of impacts related to thermal discharge. Since operation of the CPS began, heated effluent has been discharged to the lake. The amount of water, its temperature, and chemical composition are regulated by IEPA through the NPDES permit program. The IEPA regulates point sources discharging pollutants to ensure the protection and propagation of a balanced, indigenous population of fish, shellfish, and other aquatic organisms. The IEPA is required to take into consideration the cumulative impacts of multiple discharges to the same waterbody and discharges from the CPS and other area facilities will be included in the review and development of permit requirements for a new nuclear unit. Additionally, all NPDES permits must be renewed every 5 years, allowing IEPA to ensure that the permit limits provide the appropriate level of protection to the environment. During the staff's review of the suitability of the Exelon ESP site, it considered impacts from discharge of heated effluent (e.g., water temperature, dissolved oxygen, thermal stratification, impacts to Salt Creek fauna), cold shock, and chemical treatment of the cooling water. Because the NPDES permit issued by IEPA would govern the operational impacts to the aquatic environment whether the facility operated alone or jointly with the CPS, the operational impacts of water discharge from a new nuclear unit at the Exelon ESP site on aquatic organisms would normally be SMALL. However, following dry years, the cumulative impacts of operation on the aquatic environment could be MODERATE.

In addition to the impacts from construction of a new ESP unit and operation of the CPS and a new ESP unit, the staff considered the cumulative impacts for decommissioning once the power plants permanently cease operation. Decommissioning would result in the cessation of water consumption from the lake by the power plants and impingement and entrainment impacts would end. The decommissioning of one unit before the other would result in a decrease in water consumption and impingement and entrainment effects proportional to the amount of water that was consumed by the power plant that would have gone out of service. Therefore, based on the above information, the staff concludes that the contribution of a new nuclear unit cooling water intake operation to cumulative impacts on aquatic organisms in the region would be SMALL.

In summary, the staff concludes that the contribution of construction of the proposed Exelon ESP unit to the cumulative impact on aquatic ecological resources in the region would be SMALL, and mitigation measures are not warranted. The staff concludes that contribution of operational activities associated with the proposed Exelon ESP unit to the cumulative impacts related to water consumption and to impingement and entrainment of aquatic organisms would be SMALL to MODERATE, and the contribution to cumulative impacts of thermal discharge could be SMALL to MODERATE. However, additional information on the intake structure design and NPDES permit requirements for the ESP unit is needed in order to determine the impacts to aquatic ecology due to the operation of one or more nuclear units at the Exelon ESP site. Therefore, the staff concludes that the cumulative aquatic ecology issues associated with operation of a proposed ESP unit are unresolved. Finally, the staff concludes that the contribution of eventual decommissioning of the facility to the cumulative impact on aquatic ecological resources in the region would be SMALL, and mitigation measures are not warranted.

7.6 Socioeconomics, Historic and Cultural Resources, Environmental Justice

Much of the analyses of the socioeconomic impacts presented in Sections 4.5 and 5.5 already incorporate cumulative impact analysis because the metrics used for analysis only make sense when placed in the total or cumulative context. For instance, the impact of the total number of additional housing units that may be needed can only be evaluated with respect to the total number that will be available in the impacted area. Therefore, the geographical area of the cumulative analysis varies depending on the particular impact considered, and may depend on specific boundaries, such as taxation jurisdictions, or may be distance-related, as in the case of environmental justice.

The construction and operation of a new nuclear unit at the Exelon ESP site would not likely add to any cumulative socioeconomic impacts beyond those already evaluated in Sections 4.5 and 5.5. In other words, the impacts of issues such as transportation or taxes would not likely be detectable beyond the regions previously evaluated and would quickly decrease with increasing distance from the site. The staff concludes that construction and operational impacts would generally be SMALL but that there are exceptions. In Chapter 4, the staff concluded that the impacts of construction on traffic would be SMALL considering the construction workforce, the normal CPS workforce, and the temporary workforce associated with refueling outages. However, the staff concludes that the physical impacts to roads in the vicinity of the Exelon ESP site would be SMALL to MODERATE due to the heavy weight of trucks hauling construction materials into the site. Mitigation of the moderate impacts could be achieved by upgrading the existing rail line into the ESP site and using it to haul the heavier construction materials to the site.

In terms of beneficial effects, the impact on regional economies and tax revenues would be beneficially MODERATE, particularly property taxes to DeWitt County resulting from station operations. Impacts of station construction and operation on housing would be SMALL to MODERATE, particularly in DeWitt, Piatt, and Logan Counties if workers decided to locate to these smaller counties where housing is less available (but this is considered a low probability because of available housing in the larger cities near the ESP site). Aesthetic impacts of station operation would be SMALL to MODERATE. There is a concern about the impact of a new nuclear unit's cooling system on Clinton Lake water levels during times of severe drought (considered a rare event), which in turn could have impacts on the recreational use of the lake.

With regard to historic and cultural resources, the construction and operation of the ESP unit are not expected to add to any cumulative impacts to these resources beyond those identified in Sections 4.6 and 5.6. Construction, operation, and maintenance of the ESP unit would not affect land outside the bounds of the current CPS site; therefore, additional cumulative impacts would be negligible. The staff concludes that the cumulative impacts of construction and operation on historic and cultural resources would be SMALL and that mitigation would not be warranted.

The staff found no unusual resource dependencies or practices through which minority or low-income populations would be disproportionately affected. As a result, cumulative impacts of environmental justice would be SMALL.

Based on the above considerations, the staff concludes that construction and operation of a new nuclear unit at the Exelon ESP site would not likely make a detectable contribution to the cumulative effects associated with any of the socioeconomic issues, including environmental justice. The majority of overall cumulative impacts would be SMALL, and impacts that could be more severe are based on events of low probability or events that could be managed. The staff concludes that the overall cumulative impacts would be SMALL and no mitigation measures other than those identified by Exelon would be warranted.

7.7 Nonradiological Health

In Section 5.8.1, the health impacts of operation of the existing CPS and a new nuclear unit at the Exelon ESP site on the ambient temperature of Clinton Lake with regard to potential formation of thermophilic microorganisms were evaluated. The evaluation showed that the addition of a new nuclear unit would not increase the temperature in Clinton Lake enough to create an environment conducive to the optimal growth of thermophilic microorganisms. Health risks to workers can be expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts to the public and workers from noise, dust emissions, and acute electromagnetic fields were also evaluated and found to be small. The staff concludes that the cumulative impacts resulting from construction and operation of the existing CPS unit and the proposed new nuclear unit on nonradiological health would be SMALL, and that mitigation would not be warranted. Impacts from chronic electromagnetic fields remain unresolved.

7.8 Radiological Impacts of Normal Operation

The radiological exposure limits and standards for the protection of the public and for occupational exposures have been developed assuming long-term exposures and, therefore, incorporate cumulative impacts. As described in Section 5.9, the public and occupational doses predicted from the proposed operation of a new nuclear unit at the Exelon ESP site are well below regulatory limits and standards. Specifically, the site boundary dose to the maximally exposed individual from CPS and the proposed ESP unit combined would be well within the regulatory standard of 40 CFR Part 190. For purposes of this analysis, the area within an 80-km (50-mi) radius of the ESP site was included.

As stated in Section 2.5, AmerGen has conducted a radiological environmental monitoring program around the CPS site since 1980. The radiological environmental monitoring program measures radiation and radioactive materials from all sources including CPS. The U.S. Nuclear Regulatory Commission and the State would regulate any reasonably foreseeable future actions that could contribute to cumulative radiological impacts.

Therefore, the staff concludes that the cumulative radiological impacts of operation of a new nuclear unit at the Exelon ESP site and the currently operating CPS would be SMALL and that additional mitigation would not be warranted. Issues related to gas-cooled reactor design accidents are unresolved because of the lack of information.

7.9 Fuel Cycle, Transportation, and Decommissioning

The addition of the proposed new unit on the Exelon ESP site would result in the need for additional fuel. The impacts of producing this fuel include mining of the uranium ore, milling of the ore, conversion of the uranium oxide to uranium hexafluoride, enrichment of the uranium hexafluoride, fuel fabrication where the uranium hexafluoride is converted into uranium oxide fuel pellets, and disposition of the spent fuel in a proposed Federal waste repository. As discussed in Section 6.1 of this EIS, the environmental impacts of fuel cycle activities for the proposed unit would be approximately three times those presented in Table S–3 of 10 CFR 51.51. Table S–3 provides the environmental impacts from uranium fuel cycle operations for a model 1000-MW(e) light water reactor operating at 80 percent capacity with a 12-month fuel loading cycle and an average fuel burnup of 33,000 MWd/MTU. Per 10 CFR 51.51(a), the staff considers the impacts in Table S–3 to be acceptable for the 1000-MW(e) reference reactor. As discussed in Section 6.1.1 of this EIS, advances in reactors since the development of Table S–3 impacts will have the effect of reducing environmental impacts of the operating reference reactor. For example, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Fuel cycle impacts would occur not only at the Exelon ESP site but would also be scattered though other locations in the United States, or in the case of foreign-purchased uranium, in other countries. The staff considers the cumulative fuel cycle impacts of operating CPS and the proposed ESP unit to be SMALL. Cumulative impacts for other than light-water reactor designs are unresolved.

The addition of the proposed new unit would result in additional shipments of unirradiated fuel to the site and additional shipments of spent fuel and waste from the site. Cumulative impacts would be approximately twice that of the existing operating plant. Environmental impacts from transportation of unirradiated fuel, spent fuel, and waste are found in Section 6.2 of this environmental impact statement based on specific reactor types proposed for the proposed ESP unit. The following conclusions were derived from the staff's analysis of unirradiated fuel shipments: (1) the number of unirradiated fuel shipments equates to less than one truck shipment per day within criteria specified in Table S–4 of 10 CFR 51.52, (2) annual dose to workers and the public would be less than dose specified in Table S–4, and (3) health impacts are projected to be small (i.e., less than 1×10^{-4} detriment/yr). The following conclusions were derived from the staff's analysis of spent fuel: (1) after accounting for conservative assumptions in the staff's evaluation, doses to the worker and the public would be within criteria specified in Table S–4, and (2) health impacts from normal conditions and accident conditions would be small (i.e., less than 0.1 detriment/yr). Regarding transportation of waste shipments, the staff concluded that the normalized number of waste shipments would be within the value specified in Table S–4 for the 1100-MW(e) reference reactor. Cumulative impacts of transportation for operating both CPS and the proposed ESP unit would be SMALL. Cumulative impacts for other than light-water reactor designs are unresolved.

As discussed in Section 6.3 of this EIS, environmental impacts from decommissioning are expected to be small as the licensee would have to comply with decommissioning regulatory requirements. In Supplement 1 to NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, the NRC found the impacts on radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics to be small (NRC 2002). Therefore, the cumulative impacts for both the CPS and the proposed ESP unit would be SMALL. However, because Exelon was not required to (and did not) submit information regarding decommissioning in its ESP application, this issue is unresolved.

7.10 Staff Conclusions and Recommendations

The staff considered the potential cumulative impacts resulting from construction and operation of a new nuclear unit during the past, present, and future actions in the Exelon ESP site area. For each impact area, the staff concludes the potential cumulative impacts resulting from construction and operation are generally SMALL, and additional mitigation would not be warranted. However, several areas (water use and socioeconomic impacts) have the potential for a MODERATE impact. In these cases, mitigation measures may be warranted, including derating, and even shutdown, of the unit and assistance with infrastructure and public services. In certain cases (terrestrial and aquatic ecosystems, nonradiological health, and radiological impacts of operation of non-light-water reactor designs), information was not available to resolve issues. In these cases, an applicant for a construction permit or a combined license referencing the Exelon ESP would have to provide the necessary information at that stage.

7.11 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Council on Environmental Quality."

66 FR 65255 "National Pollutant Discharge Elimination System - Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase 1 Existing Facilities; Final Rule." *Federal Register*, Vol. 66, No. 243. December 18, 2001.

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Lutterbie, G. 2002. *Clinton Lake Access Areas and Fishing Guide*. Illinois Department of Natural Resources, Division of Fisheries, Springfield, Illinois.

Pallo, M.S. 1988. *Clinton Power Station Fish Impingement Report, April 1987–May 1988*. Illinois Power Company, Environmental Affairs Department, Field Biology Laboratory, Decatur, Illinois.

U.S. Atomic Energy Commission (AEC). 1974. "Final Environmental Statement Related to the Proposed Clinton Power Station Units 1 and 2." Illinois Power Company, Docket Nos. 50-461 and 50-462. Prepared by U.S. Atomic Energy Commission, Directorate of Licensing.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vols. 1 and 2, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*. NUREG-1437, Vol. 1, Addendum 1, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan (ESRP).* NUREG-1555, Vol. 1, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Vols. 1 and 2, Washington, D.C.

8.0 Environmental Impacts of the Alternatives

This chapter describes alternatives to the proposed action and discusses the environmental impacts of those alternatives. The evaluation of alternative sites is a two-step process, as set forth in NUREG-1555, Section 9.3 (NRC 2000), and stems from the U.S. Nuclear Regulatory Commission (NRC) decision related to licensing the Seabrook Nuclear Power Plant (CLI-77-8, 5 NRC 503, 1977). The first step looks at a full suite of environmental issues, using reconnaissance-level information to determine if any of the alternative sites are environmentally preferable to the proposed site. If an alternative site appears environmentally preferable to the proposed site, then the analysis proceeds to the second step. If not, then the evaluation of alternative sites ends at the first step. The second step considers economic, technological, and institutional factors among the environmentally preferred sites to determine if any site is obviously superior to the proposed site. If there is no obviously superior site, then the proposed site prevails. A staff conclusion that an alternative site is obviously superior to Exelon's proposed site would normally lead to a recommendation that the early site permit (ESP) application be denied.

The environmental impacts of the alternatives are evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B. The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a], including the additional impact category of environmental justice. While the GEIS was developed for license renewal, it provides useful information for this review and is referenced throughout this chapter.

Because 10 CFR Part 52 does not require an Environmental Report (ER) or environmental impact statement (EIS) for an ESP to include consideration of the benefits of construction and operation of a new reactor or reactors at the ESP site, this EIS does not consider such matters. Accordingly, should the NRC issue an ESP for the Exelon site, these matters would be considered in the EIS for any construction permit (CP) or combined license (COL) application that references such an ESP.

Section 8.1 discusses the no-action alternative. Section 8.2 addresses alternative energy sources. Section 8.3 examines the design alternatives. Section 8.4 reviews Exelon's region of interest (ROI) and examines the suitability of the ROI and Exelon's alternative site-selection process. It describes the method Exelon used to select the candidate and alternative sites.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Section 8.5 evaluates the selected alternative sites individually. Section 8.6 examines issues that are common to all the sites and addresses them collectively for all the sites. Section 8.7 summarizes the environmental impacts for the alternative sites. The comparison of the alternative sites with the proposed site is made in Chapter 9.

8.1 No-Action Alternative

For purposes of this ESP application, the no-action alternative refers to a scenario in which the NRC would deny the ESP request. Upon such a denial, the construction and operation of a new nuclear power station at the proposed ESP location in accordance with the 10 CFR Part 52 process referencing an approved ESP would not occur.

The no-action alternative consists of two parts. First, the no-action alternative would include a scenario in which the NRC would not issue the ESP. There are no environmental impacts associated with not issuing the ESP except that the impacts associated with site-preparation and preliminary work allowed pursuant to 10 CFR 52.17(c) and 10 CFR 52.25(a) would be avoided. Second, given that the EIS addresses the environmental effects of construction and operation as directed by the Commission in 10 CFR 52.18(a)(2), the no-action alternative would result in no such construction and operation. Therefore, the impacts predicted in this EIS would not occur.

In this context, the no-action alternative would accomplish none of the benefits intended by the ESP process, which would include (1) early resolution of siting issues prior to large investments of financial capital and human resources in new plant design and construction, (2) early resolution of issues on the environmental impacts of construction and operation of reactors that fall within the plant parameters, (3) the ability to bank sites on which nuclear plants may be located, and (4) the facilitation of future decisions on whether to build new nuclear plants.

8.2 Energy Alternatives

This section examines the potential environmental impacts associated with electric generating sources other than a new nuclear unit at the Exelon ESP site; purchasing electric power from other sources to replace power that would have been generated by a new unit at the ESP site; a combination of new generating capacity and conservation measures; and other generation alternatives that were deemed not to be viable replacements for a new unit at the ESP site.

A new nuclear unit at the Exelon ESP site would be constructed and operated as a merchant independent power producer (also referred to as a “merchant plant” or “merchant generator”). The power produced would be sold on the open wholesale market, without specific consideration to supplying a traditional service area or satisfying a reserve margin objective.

Thus, for the purpose of this alternatives analysis, an ROI has been defined by Exelon as the State of Illinois rather than the more traditional "relevant service area." The delineation of this ROI is in keeping with current deregulation policies and the proposed location of the facility within the State of Illinois.

8.2.1 Alternatives Not Requiring New Generating Capacity

As described in its ER, from Exelon's perspective, alternatives not requiring additional generation are not reasonable alternatives to a merchant plant. Nevertheless, Exelon considered alternatives not requiring new generating capacity (Exelon 2006). This section provides an assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific elements of analysis could include one or more of the following:

- Initiating energy-conservation measures (including implementing demand-side management actions)
- Purchasing power from other utilities or power generators
- Reactivating or extending the service life of existing plants within the power system.

8.2.1.1 Energy Conservation

Historically, State regulatory bodies have required regulated utilities to institute programs designed to reduce demand for electricity. Demand-side management programs included energy-conservation and load-modification measures. In the current deregulated Illinois market, Exelon anticipates that it will not be able to offer competitively priced power if it has to retain an extensive program involving conservation and load-modification incentives (Exelon 2006).

The Commission determined (NRC 2005) that conservation or demand side management programs are not a reasonable alternative to an ESP for a base load nuclear power plant. Consequently, that alternative is not further considered.

8.2.1.2 Purchased Power

Power generation is expected to be fully deregulated by the time Exelon would apply for a CP or COL for the ESP site (Exelon 2006). Overall, Illinois is a net exporter of electricity.

If available, purchased power from other sources could make a new nuclear unit at the ESP site unnecessary. Imported power from Canada or Mexico is unlikely to be available to supply the equivalent capacity of a new unit at the site. In Canada, 60 percent of the country's electricity capacity is derived from renewable sources, principally hydropower (DOE/EIA 2004a). Canada has plans to continue developing hydroelectric power, but the plans generally do not include large-scale projects (DOE/EIA 2004a). Canada's nuclear generation is projected to increase from 10,018 megawatts in 2001 to 15,207 megawatts by 2020, or an increase of 52 percent, before beginning to decline to 12,351 megawatts at the end 2025 (DOE/EIA 2004a). The U.S. Department of Energy's (DOE) Energy Information Administration (EIA) projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.4 billion kilowatt-hours in 2000 to 66.1 billion kilowatt-hours in 2005, and then gradually decrease to 47.4 billion kilowatt-hours in 2020 (DOE/EIA 2001a).

Exelon has evaluated conventional and prospective purchase power supply options that could be reasonably implemented in Illinois. In 1999, Unicom's subsidiary ComEd completed a sale of its coal, gas, and oil units to Midwest Generation. As part of the sale, Unicom entered into long-term purchase contracts with Midwest Generation to provide firm capacity and energy (ComEd 1999). Power covered by these contracts is already included in current and future capacity estimates. Therefore, Exelon does not consider the power purchased by these contracts to be available to satisfy the purchased power alternative.

If power to replace the capacity of a new nuclear unit were to be purchased from sources within the United States or from a foreign country, the generating technology likely would be one of those described in the GEIS for License Renewal (probably coal, natural gas, or nuclear) (NRC 1996). The description of the environmental impacts of other technologies described in the GEIS is representative of the impacts associated with the construction and the operation of a new nuclear unit at the ESP site. Under the purchased power alternative, the environmental impacts of power production would still occur, but would be located elsewhere within the region or the Nation or in another country. The environmental impacts of coal-fired and natural gas-fired plants are discussed in Section 8.2.2.

If the purchased power alternative is implemented, the only environmental unknown is whether new transmission line rights-of-way would be required. The construction of these lines could have both environmental and aesthetic consequences, particularly if new transmission line rights-of-way have to be acquired. The staff concludes that the local environmental impacts from purchased power would be SMALL when existing transmission line rights-of-way are used and could range from SMALL to LARGE if acquisition of new rights-of-way is required. The environmental impacts of power generation depend on the generation technology and location of the generation site and are, therefore, unknown.

8.2.1.3 Extending the Service Life of Existing Plants

Fossil plants slated for retirement, predominately coal- and natural-gas-fired plants, tend to be ones that are old enough to have difficulty in economically meeting today's restrictions on air-contaminant emissions and, as a result, would require extensive refurbishing to meet the more restrictive environmental standards at great economic cost. As a result, Exelon concluded that the environmental impacts of a refurbishment scenario are bounded by its coal- and natural-gas-fired alternatives.

Nuclear power plants are initially licensed for a period of 40 years. The license can be renewed for 20 years, and regulations permit additional license renewal. Exelon did not consider nuclear power plant license renewal in its ER. However, renewed operating licenses were granted for Quad Cities, Units 1 and 2, and Dresden, Units 2 and 3, which are located at alternative ESP sites. The operating licenses for reactors at the Braidwood, Byron, and LaSalle sites may be renewed in the future. The reactors at the Zion site have permanently ceased operation, and the option of renewal of the operating licenses no longer exists for these reactors.

The environmental impacts of continued operation of a nuclear power plant are significantly less than construction of a new plant. However, continued operation of an existing nuclear plant does not provide additional generating capacity.

The NRC regulates the maximum power at which a commercial nuclear power plant may operate to ensure safety of the plant. Licensees may request NRC approval to increase the maximum power level of a plant (i.e., a power uprate). Exelon has already requested and obtained approval for power uprates for each of its nuclear power plants in Illinois. The NRC approved power uprates for LaSalle Units 1 and 2 in 2000; Byron Units 1 and 2, Braidwood Units 1 and 2, Dresden Units 2 and 3, and Quad Cities Units 1 and 2 in 2001; and Clinton in 2002. Additional power uprates for these plants will not provide the new generating capacity being considered by Exelon.

8.2.1.4 Conclusions

The staff concludes that the options of purchasing electric power from other suppliers, reactivating retired power plants, and extending the operating life of existing power plants are not reasonable alternatives to providing new base load power generation capacity.

8.2.2 Alternatives Requiring New Generating Capacity

In keeping with the NRC's evaluation of alternatives to license renewal, a reasonable set of energy alternatives to the construction and operation of a new nuclear unit at the Clinton ESP site should be limited to analysis of single discrete power generation sources and those power generation technologies that are technically reasonable and commercially viable (NRC 1996). The current mix of power-generation options in Illinois is one indicator of the feasible choices for electrical generation technology within the State. Exelon employed the criterion of generation capacity (installed technology choices in terms of its potential output) and utilization characteristics (the degree to which each choice is actually used) to select those technologies to be evaluated.

8.2.2.1 Coal-Fired Generation

In 2001, coal-fired steam electric plants provided about 49 percent of the electric power generation in the United States. The share of coal-fired power generation is projected to increase from 49 percent in 2001 to 52 percent in 2025 as rising natural gas prices improve the cost competitiveness of coal-fired technologies. Some 112 gigawatts of new coal-fired generating capacity is expected to be constructed by 2025 (DOE/EIA 2004b). However, in Illinois coal-fired generation fell from 46.1 percent of total generating capacity in 1993 to 35.0 percent in 2002 (DOE/EIA 1998).

The environmental impacts of constructing and operating a typical coal-fired steam plant are well known and can be substantial. Exelon defined the coal-fired alternative as four 550-MW(e) units. Exelon chose this configuration to have parity with the gas-fired alternative described in Section 8.2.2.2. Exelon based its emission-control technology and percent-control assumptions on alternatives that the U.S. Environmental Protection Agency (EPA) has identified as being available for minimizing emissions (EPA 1998). For the purposes of analysis, Exelon has assumed that coal and lime (calcium oxide) would be delivered by rail to the Clinton site. The staff has reviewed Exelon's assumptions, compared them to other resource material (including NRC 1996), and has found them to be reasonable.

Two types of cooling systems can be used for a coal-fired system: closed-cycle and once-through cooling. A closed-cycle system uses cooling towers, thus creating some aesthetic impacts and potential ecological impacts from cooling tower spray drift. Once-through cooling systems do not use cooling towers, resulting in less land being impacted. However, with respect to surface-water use and quality, there would be an increased thermal load on the receiving body of water, with ecological and aquatic impacts.

Air Quality

The fugitive dust emissions from construction activities for a coal-fired generation plant are expected to be mitigated using best management practices; emissions will be temporary. The impacts to air quality from coal-fired generation would vary considerably from those of nuclear power generation because of emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulates, and hazardous air pollutants, such as mercury. Exelon has assumed a plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. Exelon (Exelon 2006) estimates the coal-fired alternative emissions for SO_x, NO_x, CO, and total suspended particulates (TSP) and its subset of particulate matter (PM) of 10 microns in diameter or less (PM_{10}) to be as follows:

- SO_x = 7373 MT (8127 tons) per year
- NO_x = 1863 MT (2054 tons) per year
- CO = 1921 MT (2118 tons) per year
- PM:
  - -TSP = 265 MT (292) tons per year
  - -PM_{10} = 61 MT (67 tons) per year

In 2002, emissions of SO_2, NO_x, and CO from Illinois's generators ranked 11th, 4th, and 6th highest nationally, respectively (DOE/EIA 2004b). In fact, 17 Illinois generators were cited in the Clean Air Act Amendments of 1990, which required that they be in compliance with stricter emission controls for SO_2 and NO_x by 1995 (Exelon 2006). The acid rain requirements of the Clean Air Act Amendments capped the Nation's SO_2 emissions from power plants. Exelon would have to obtain sufficient pollution credits either from a set-aside pool or purchases on the open market to cover annual emissions from the plant.

The market-based allowance system used for sulfur dioxide emissions is not used for nitrogen oxide emissions. Therefore, this approach may not be feasible for NO_x emissions. The Illinois Environmental Protection Agency (IEPA) allocated NO_x credits among the existing coal-fired generating units in the State (IAC 2004). A new coal-fired power plant would be subject to the new source performance standard for such plants (40 CFR 60.44a(d)(1)), which limits the discharge of any gases that contain nitrogen oxides (expressed as nitrogen dioxide) to 200 ng/J (1.6 lb/MWh) of gross energy output, based on a 30-day rolling average. Mitigation efforts for air-pollution emissions (e.g., emissions trading) generally apply to nonattainment areas. The Clinton ESP site is in an attainment area. Only a small percentage of credits were set aside by the IEPA for new sources. The ESP site would be classified as a new source (Exelon 2006). Under the current circumstances, mitigation strategies for air emissions could be economically prohibitive.

A new coal-fired generation plant would likely need a prevention of significant deterioration permit and an operating permit under the Clean Air Act Amendments of 1990. The plant would need to comply with the new source performance standards for such plants in 40 CFR Part 60, Subpart Da. The standards establish emission limits for particulate matter and opacity (40 CFR 60.42a), sulfur dioxide (40 CFR 60.43a), and nitrogen oxide (40 CFR 60.44a).

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment for unclassified for criteria pollutants under the Clean Air Act.

Criteria pollutants under the Clean Air Act are lead, ozone, particulates, carbon monoxide, nitrogen oxides, and sulfur dioxide. Ambient air quality standards for criteria pollutants are in 40 CFR Part 50. The Clinton ESP site is in an area designated as in attainment or unclassified for criteria pollutants (40 CFR 81.325).

Section 169A of the Clean Air Act (42 USC 7491) establishes a National goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment occurs because of air pollution resulting from human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for those days on which visibility is most impaired over the period of the implementation plan and ensure no degradation in visibility for the least visibility-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal-fired power generation station were located close to a mandatory Class I area, then additional air pollution control requirements would be imposed. There are no mandatory Class I Federal areas in Illinois or downwind in Indiana.

Exelon did not estimate the carbon dioxide emissions from its coal-fired alternative. However, assuming a typical carbon dioxide emission rate of 1 kg/kWh (2 lb/kWh) for coal-fired power plants (DOE/EPA 2000) and a capacity factor of 0.85 (Exelon 2006), the coal-fired alternative would result in emission of approximately 15 million MT (16 million tons) of carbon dioxide per year. These estimates only consider the carbon dioxide release by the power plant; they do not include carbon dioxide releases in the remainder of the coal fuel cycle.

The staff concludes that the environmental impacts on air quality of coal-fired power generation of 2200 MW(e) at the Exelon ESP site would be MODERATE to LARGE. The impacts would be clearly noticeable and, given the current state of Illinois air quality for SO_x and NO_x, could destabilize air quality.

Waste Management

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, and scrubber sludge. Exelon estimates that coal-fired generation of 2200 MW(e) would consume 7.7×10^6 MT (8.5×10^6 tons) of coal and produce approximately 5.3×10^5 MT (5.8×10^5 tons) of recoverable ash per year. Eighty-seven percent of the ash would be recycled, leaving approximately 6.9×10^4 MT (7.6×10^4 tons) of ash per year for disposal. SO_x-control equipment would generate another 4.0×10^5 MT (4.4×10^5 tons) per year of waste in the form of scrubber sludge. Approximately 94 ha (234 ac) would be required as a waste disposal site for both the ash and sludge over the 40-year life of the plant (Exelon 2006).

In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (EPA 2000). The EPA concluded that some form of national regulation is warranted to address coal-combustion waste products because of health concerns. Accordingly, EPA announced its intention to issue regulations for disposal of coal-combustion waste under Subtitle D of the Resource Conservation and Recovery Act of 1976. Exelon concludes that waste disposal would not destabilize any resources with proper placement of the facility, coupled with current waste-management and monitoring practices. There would be space within the ESP site footprint for this disposal. After closure of the waste site and revegetation, the land would be available for other uses (Exelon 2006).

For the reasons stated above, the staff concludes that the impacts of disposing of waste generated from burning coal would be MODERATE.

Human Health

Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risks from coal and lime/limestone transportation, worker and public risks from disposal of coal-combustion wastes, and public risks from inhalation of stack emissions. In addition, the discharges of uranium and thorium from coal-fired plants can produce radiological doses in excess of those from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including the EPA and State agencies, set air-emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. The EPA has recently concluded that certain segments of the United States population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. However, given the regulatory oversight exercised by the EPA and State agencies, the staff concludes that the human health impacts from radiological doses and inhaling toxins and particulates generated by burning coal at newly constructed coal-fired plants would be SMALL.

Other Impacts

Construction of the power block and coal storage area would impact approximately 120 ha (300 ac) of land at the Clinton site. This land was disturbed during construction of Clinton Power Station (CPS). Additional land might be needed in the site vicinity for transportation facilities, infrastructure facilities, waste disposal, rail spur, and cooling water intake and discharge facilities. Further impacts for coal and limestone mining would occur in areas remote from the ESP site. Therefore, the staff concludes that the land-use impacts of siting, constructing, and operating a coal-fired unit at the ESP site would be MODERATE.

Constructing and operating a coal-fired generation plant would have ecological impacts that could include wildlife habitat loss and fragmentation, reduced productivity, and a local reduction in biological diversity. The impacts could occur at the ESP site and at the sites used for coal and limestone mining. Extraction of additional cooling makeup water could have adverse impacts on aquatic resources. Construction and maintenance of a rail spur and, if needed, new or improved transmission lines would have ecological impacts. Cooling tower drift would have minimal impacts on terrestrial ecology. Disposal of fly ash could affect water quality and the aquatic environment. The impacts to threatened or endangered species would be similar to those of a new nuclear plant. Overall, the staff concludes that the ecological impacts would be MODERATE to LARGE.

Erosion and sedimentation from construction activities would be minimized by using best management practices. Impacts to water use and water quality would be MODERATE due to the plant's use of a new cooling water system if once-through cooling were used. Use of cooling towers for coal-fired generation would reduce cooling water intake and discharge water usage by 90 percent compared to once-through cooling. Hybrid wet/dry cooling towers might be used to reduce makeup water consumption to match water demand with available water supply. The staff concludes that the impacts to water resources would be SMALL, if cooling towers were employed, or MODERATE to LARGE, if they were not.

Socioeconomic impacts would result from the approximately 250 people needed to operate the coal-fired facility, demands on housing and public services during the construction period, and loss of jobs after construction. The staff concludes that these impacts would be SMALL, due to the mitigating influence of the site's proximity to the surrounding population area and the small number of employees required to operate the plant. The plant would pay property taxes to DeWitt County. Considering the population and economic condition of the County, the staff concludes that the taxes would have a MODERATE to LARGE (beneficial) impact on the County.

Constructing and operating a coal-fired unit would be consistent with the industrial nature of the ESP site. Coal delivery would add noise and transportation impacts associated with train traffic. Considering the rural character of the surrounding area, the staff concludes that these impacts would be SMALL. Although best management practices would be expected to be implemented to mitigate impacts (for example, noise), the viewshed would be impacted by the presence of large physical structures and plumes from a stack and from cooling towers, if cooling towers were employed. Therefore, the staff concludes that visual and aesthetic impacts of coal-fired power generation would be MODERATE.

The ESP site was disturbed during construction of the CPS. As a result, historic and cultural resource impacts would be unlikely and could be minimized by survey and recovery techniques, if needed. A cultural resources inventory would likely be needed for any on-site property that had not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recovery of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. Before construction, studies would likely be needed to identify, evaluate, and address mitigation of the potential impact of new power plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site, any offsite affected areas, such as mining and waste disposal sites, and along associated corridors where new construction would occur (for example, roads, transmission line rights-of-way, rail lines, or other rights-of-way). Therefore, the staff concludes that historic and cultural resource impacts would be SMALL.

There is no evidence of environmental justice issues at the ESP site. Therefore, the staff concludes that environmental justice impacts would be SMALL.

Other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these impacts, mitigation would not be warranted beyond that discussed.

The environmental impacts of constructing coal-fired power generation of 2200 MW(e) at the ESP site are summarized in Table 8-1.

8.2.2.2 Natural-Gas-Fired Generation

Exelon chose to evaluate natural-gas-fired generation. Four natural-gas-fired, combined-cycle plants of 550-MW(e) net capacity, consisting of two 184-MW(e) gas turbines (e.g., General Electric Frame 7FA) and 182 MW(e) of heat-recovery capacity were considered for a total of 2200 MW(e). Exelon based its emission control technology and emission control assumptions on alternatives that the EPA has identified as being available for minimizing emissions (EPA 1998). For the purposes of analysis, Exelon has assumed that there would be sufficient natural gas available. The staff reviewed Exelon's assumptions and found them reasonable.

Natural gas-fired generators can also employ closed-cycle or once-through cooling systems. A closed-cycle system uses cooling towers, thus creating some aesthetic impacts and potential ecological impacts from cooling tower spray drift. Once-through cooling systems do not use cooling towers, resulting in less land being impacted. However, with respect to surface-water use and quality, there would be an increased thermal load on the receiving body of water, with ecological and aquatic impacts. The environmental impacts would be similar to those of a coal-fired generating system employing the same technology.

Table 8-1. Summary of Environmental Impacts of Coal-Fired Power Generation - 2200 MW(e)

Impact Category	Impact	Comment
Air Quality	MODERATE to LARGE	SO_x: 7373 MT (8127 tons) per year NO_x: 1863 MT (2054 tons) per year CO: 1921 MT (2118 tons) per year TSP: total PM: 265 MT (292 tons) per year PM_{10}: 61 MT (67 tons) per year Some hazardous air pollutants.
Waste Management	MODERATE	69,000 MT (76,000 tons) of ash would require disposal. 400,000 MT (440,000 tons) of scrubber sludge would require disposal. 94 ha (234 ac) would be needed for ash and sludge disposal.
Human Health	SMALL	Regulatory controls and oversight would be protective of human health.
Land Use	MODERATE	120 ha (300 ac) of previously disturbed land at the ESP site for power block and coal storage area. Additional land may be needed for infrastructure and other facilities. Mining activities would have additional impacts offsite.
Ecology	MODERATE to LARGE	Construction of a new cooling-water system. Potential impacts from transmission; potential habitat loss and fragmentation; reduced productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to LARGE	Impact depends on volume of water withdrawal and discharge, the constituents in the discharge water, and the characteristics of the surface-water body. Discharge of cooling tower blowdown would have impacts if cooling towers were built.
Socioeconomic	SMALL (Adverse) to LARGE (Beneficial)	Impacts from 250 people to operate plant would be absorbed easily across the region. Property tax impacts to DeWitt County would have a significant beneficial impact. Construction worker impacts would be temporary.
Aesthetics	MODERATE	ESP site is zoned industrial and located in a rural area. Existing operating nuclear facility onsite. Construction impacts minimized through use of best management practices. Viewshed would have permanent impacts from physical structures and plumes.
Historic and Cultural Resources	SMALL	Any potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built on previously disturbed ground. Impacts to offsite properties could be mitigated by inventory, identification and recovery techniques.
Environmental Justice	SMALL	No evidence of environmental justice issues around the ESP site.

Air Quality

It is expected that the fugitive dust emissions from construction activities for a natural gas-fired generation plant would be mitigated using best management practices, so emissions would be temporary. Natural gas is a relatively clean-burning fossil fuel and is more efficient in generating electricity than a similar size coal-fired plant. It would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Exelon estimated the natural-gas-fired alternative emissions as follows (Exelon 2006):

- SO_x = 161 MT (177 tons) per year
- NO_x = 515 MT (568 tons) per year
- CO = 109 MT (120 tons) per year
- TSP = 90 MT (99 tons) per year (all particulates are PM_{10}).

Control technology for natural-gas-fired turbines focuses on the reduction of NO_X emissions. Clean Air Act requirements for coal-fired generation, discussed in 8.2.2.1, are also applicable to the gas-fired generation alternative. NO_x effects on ozone levels, SO_x allowances, and NO_x emission offsets could be issues of concern for gas-fired combustion. There are no mandatory Class I Federal areas in Illinois or downwind in Indiana.

Exelon did not estimate the carbon dioxide emissions from its gas-fired alternative. However, assuming a typical carbon dioxide emission rate of 0.6 kg/kWh (1.3 lb/kWh) for gas-fired power plants (DOE/EPA 2000) and a capacity factor of 0.85 (Exelon 2006), the gas-fired alternative would result in emission of approximately 10 million MT (11 million tons) of carbon dioxide per year. These estimates only consider the carbon dioxide release by the power plant; they do not include carbon dioxide released in the remainder of the gas fuel cycle.

The staff concludes that the environmental impacts on air quality of natural gas-fired power generation of 2200 MW(e) at the Exelon ESP site would be SMALL to MODERATE.

Waste Management

Natural gas-fired power generation would result in almost no waste generation. Combustion of natural gas results in few by-products because of the clean nature of the fuel. The only significant waste generated at a natural-gas-fired plant would be the catalyst used in control of NO_x emissions. The spent catalyst, estimated by the NRC staff to be approximately 38 m^3/yr, could be regenerated or disposed of offsite. Overall, the staff concludes that the waste impacts would be SMALL for natural gas-fired power generation.

Human Health

In the GEIS for License Renewal, the staff identified cancer and emphysema as potential health risks from natural gas-fired plants (NRC 1996). NO_x emissions contribute to ozone formation, which in turn affects human health. However, it is not expected that human health effects would be detectable. Therefore, the staff concludes that the impacts of natural gas-fired power generation on human health would be SMALL.

Other Impacts

The staff estimates that 44 ha (110 ac) would be needed for a four natural gas-fired, combined-cycle plant. The disturbed land area at the ESP site exceeds this land requirement (Exelon 2006). The construction of a pipeline to bring natural gas to the CPS site would result in land impacts. To minimize such impacts, Exelon would route the pipeline along previously disturbed rights-of-way to the extent practical. There could be some temporary ecological damage associated with the burial of the pipeline underground. An easement encompassing 12 to 16 ha (30 to 40 ac) would need to be graded to install the pipeline (Exelon 2006). Therefore, the staff concludes that the land use environmental impacts would be SMALL.

Constructing and operating a natural gas-fired generation plant would have limited ecological impacts at the ESP site. Withdrawal of additional cooling makeup water could have adverse impacts on aquatic resources. Construction and maintenance of the natural gas pipeline and, if needed, new or improved transmission lines would have ecological impacts. Cooling tower drift would have minimal impacts on terrestrial ecology. The impacts to threatened or endangered species would be similar to those of a new nuclear unit. Overall, the staff concludes that the ecological impacts would be SMALL to MODERATE.

Erosion and sedimentation from construction activities would be minimized by using best management practices. Impacts to water use and water quality would be MODERATE due to the unit's use of a new cooling water system if once-through cooling were used. Use of cooling towers for gas-fired generation would reduce cooling water intake and discharge water usage by 90 percent compared to once-through cooling. Hybrid wet/dry cooling towers might be used to reduce makeup water consumption to match water demand with available water supply. The staff concludes that the impacts to water resources would be SMALL, if cooling towers were employed, or MODERATE to LARGE, if they were not.

Socioeconomic impacts would result from the approximately 40 to 80 people needed to operate the natural gas-fired facility, demands on housing and public services during the construction period, and loss of jobs after construction. The staff concludes that these impacts would be SMALL due to the mitigating influence of the site's proximity to the surrounding population area and the small number of employees required to operate the unit. The plant would pay property taxes to DeWitt County. Considering the population and economic condition of the County, the staff concludes that the taxes would have a MODERATE to LARGE (beneficial) impact on the County.

Constructing and operating a natural gas-fired unit would be consistent with the industrial nature of the ESP site. Considering the rural character of the surrounding area, the staff concludes that noise-related impacts would be SMALL. Although best management practices would be expected to be implemented to mitigate impacts, the viewshed would be impacted by the presence of large physical structures and plumes from a stack and from cooling towers, if cooling towers were employed. Therefore, the staff concludes that visual and aesthetic impacts of natural gas-fired power generation would be MODERATE.

The ESP site was disturbed during construction of the CPS. As a result, historic and cultural resource impacts would be unlikely and could be minimized by survey and recovery techniques, if needed. A cultural resources inventory would likely be needed for any on-site property that had not been previously surveyed. Other lands, if any, that are acquired to support the unit would also likely need an inventory of field cultural resources, identification and recovery of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. Before construction, studies would likely be needed to identify, evaluate, and address mitigation of the potential impact of new power plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and any offsite affected areas where new construction would occur (for example, roads, transmission line rights-of-way, pipelines, or other rights-of-way). Therefore, the staff concludes that historic and cultural resource impacts would be SMALL.

There is no evidence of environmental justice issues at the ESP site. Therefore, the staff concludes that environmental justice impacts would be SMALL.

Other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these impacts, mitigation would not be warranted beyond that mentioned.

The environmental impacts of constructing natural gas-fired power generation of 2200 MW(e) at the ESP site are summarized in Table 8-2.

Table 8-2. Summary of Environmental Impacts of Natural Gas-Fired Power Generation - 2200 MW(e)

Impact Category	Impact	Comment
Air Quality	SMALL to MODERATE	SO_x: 161 MT (177 tons) per year NO_x: 515 MT (568 tons) per year CO: 109 MT (120 tons) per year TSP: all PM_{10}: 90 MT (99 tons) per year Some hazardous air pollutants.
Waste Management	SMALL	38 m^3 of spent catalyst would be regenerated or would require disposal.
Human Health	SMALL	Health effects would not be detectable if technology met regulatory controls.
Land Use	SMALL	44 ha (110 ac) of previously disturbed land at the ESP site for power block, offices, roads, and parking areas. Additional land might be needed for infrastructure and other facilities.
Ecology	SMALL to MODERATE	Construction of a new cooling-water system. Potential impacts from transmission; limited habitat loss and fragmentation; limited impact to productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to LARGE	Impact depends on volume of water withdrawal and discharge, the constituents in the discharge water, and the characteristics of the surface-water body. Discharge of cooling tower blowdown would have impacts if cooling towers were built.
Socioeconomic	SMALL (Adverse) to LARGE (Beneficial)	Impacts from 40-80 people to operate plant would be absorbed easily across the region. Property tax impacts to DeWitt County would have a significant beneficial impact. Construction worker impacts would be temporary.
Aesthetics	MODERATE	ESP site is zoned industrial and located in a rural area. Existing operating nuclear facility onsite. Construction impacts minimized through use of best management practices. Viewshed would have permanent impacts from physical structures and plumes.
Historic and Cultural Resources	SMALL	Any potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built on previously disturbed ground. Impacts to offsite properties could be mitigated by inventory, identification and recovery techniques.
Environmental Justice	SMALL	No evidence of environmental justice issues around the ESP site.

8.2.3 Other Alternatives

This subsection discusses alternatives that Exelon has determined are not reasonable, the basis given by Exelon for this determination, and the staff conclusions about the overall environmental impact of each alternative. A new nuclear unit at the ESP site would be a baseload generator and merchant plant. Any feasible alternative to this facility would need to generate baseload power. In performing its initial evaluation in the ER, Exelon relied heavily on the GEIS for License Renewal (NRC 1996). Subsequently, in response to an NRC request, Exelon submitted an updated analysis of the wind and solar alternatives (Exelon 2004b). The staff reviewed the information submitted by Exelon and conducted its own independent review and finds that Exelon's conclusion that these generation options are not reasonable alternatives to a new nuclear unit is acceptable.

The staff has not assigned significance levels to the environmental impacts associated with the alternatives discussed in this section because, in general, the generation alternatives would have to be installed at a location other than the ESP site. Any attempt to assign significance levels would require staff speculation about the unknown site.

8.2.3.1 Wind

The current estimate of the National Renewable Energy Laboratory is that there are approximately 1800 km^2 (700 mi^2) of land in Illinois suitable for wind development with a 9000-MW(e) wind potential (NREL 2004). The closest region to the ESP site with a good wind resource is found in the Bloomington area, about 40 km (25 mi) north of the site.

There have been various environmental concerns related to wind generation, including land usage and bird collisions. Approximately 20 ha (50 ac) are required per installed MW(e). This requirement is about a factor of 3 lower than estimated in the GEIS for License Renewal (NRC 1996) and assumed by Exelon (2006). Although the land requirement for wind generation is large, only a small fraction of the total land requirement need be dedicated solely to wind generation. Much of the land in the vicinity of wind turbines can be used for agriculture. Bird collisions have not proven to be the problem that was predicted. They have only been a serious concern at one location, Altamont Pass in California. The wind industry has learned to avoid locations that pose problems for birds (DeMeo and Parsons 2003).

However, wind power, by itself, is not suitable for large baseload capacity. As discussed in the GEIS for License Renewal (NRC 1996), wind has a high degree of intermittence, and average annual capacity factors for wind plants are relatively low (less than 30 percent). In conjunction with energy storage mechanisms, wind power might serve as a means of providing base-load power. However, current energy storage technologies are too expensive for wind power to serve as a large baseload generator. Based on the intermittent nature of the wind resource, the staff concludes that wind power generation is not a viable alternative to the baseload capacity that would be offered by a new nuclear unit at the ESP site.

8.2.3.2 Geothermal

Although geothermal plants might be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent (NRC 1996), there are no high-temperature geothermal sites in Illinois. Therefore, the staff concludes that geothermal is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.3 Hydropower

A small portion (about 80 MW) of Illinois utility generating capacity is hydroelectric. As discussed in the GEIS for License Renewal (NRC 1996), the percentage of U.S. generating capacity from hydropower is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern over flooding, destruction of natural habitat, and destruction of natural river courses. According to the U.S. Hydropower Resource Assessment for Illinois (INEL 1997), there are no remaining sites in Illinois that would be environmentally suitable for a large hydroelectric facility.

The GEIS for License Renewal (NRC 1996) estimates land-use requirements of 4100 km^2 (1600 mi^2) per 1000 MW(e) for hydroelectric power. Based on this estimate, a project the size of a new nuclear unit at the ESP site would require the flooding of more than 9120 km^2 (3520 mi^2) of land, resulting in a large impact on land use (Exelon 2006). Further, operation of a hydroelectric facility could alter aquatic habitats above and below the dam, thereby impacting existing aquatic species. Exelon concluded that, due to the lack of suitable sites in Illinois and the amount of land needed, hydropower is not a reasonable alternative to a new nuclear unit at the ESP site (Exelon 2006).

The staff reviewed Exelon's discussion on hydropower and independently verified the analysis. The staff concludes that hydropower is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.4 Solar Thermal Power and Photovoltaic Cells

Solar technologies use energy and light from the sun to provide heating and cooling, light, hot water, and electricity for consumers. Solar power technologies (both photovoltaic and thermal) cannot currently compete with conventional nuclear and fossil-fueled technologies in grid-connected applications because of solar power's higher capital cost per kilowatt of capacity. The cost of solar power using concentrating technologies is $0.09 to $0.12 per kilowatt-hour (SNL 2005). Energy storage requirements also limit the use of solar energy systems as baseload electricity supply. In the GEIS for license renewal, the staff determined that the average capacity factor of photovoltaic cells is about 25 percent, and the capacity factor for solar thermal systems is about 25 to 40 percent (NRC 1996).

Construction of solar generating facilities has substantial impacts on natural resources (such as wildlife habitat, land-use, and aesthetics). As stated in the GEIS for License Renewal, land requirements are high—142 km^2 (55 mi^2) per 1000 MW(e) for photovoltaic (NRC 1996) and approximately 57 km^2 (22 mi^2) per 1000 MW(e) for solar thermal systems (NRC 1996). Although more recent information indicates that these land requirement estimates may be high (e.g., SNL 2005), neither type of solar electric system would fit the land area footprint available at the Exelon ESP site.

The solar resource for the Exelon ESP site is an annual average of 4.0 to 4.5 $kWhr^2$ per day for flat-plate solar systems, and 3.5 to 4.0 $kWhr/m^2$ per day for solar concentrating systems. Areas in the southwest United States receive up to 7.5 $kWhr/m^2$ per day (DOE 2005). For the preceding reasons, the staff concludes that a solar energy facility at or in the vicinity of the Exelon ESP site would not be a viable alternative to a nuclear power generation plant that would be operated as a baseload plant.

8.2.3.5 Wood Waste

A wood-waste burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent energy-conversion efficiency (NRC 1996). The energy-conversion efficiency of a conventional fossil-fired plant is on the order of 35 percent.

The fuels required for a wood-waste burning facility are variable and site-specific. A significant barrier to the use of wood waste to generate electricity is the high delivered fuel cost and high construction cost per MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in the GEIS for License Renewal (NRC 1996) suggest that the overall level of construction impact per MW of installed capacity would be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment. The use of wood waste to generate electricity is largely limited to those states with significant wood resources, such as California, Oregon, Washington, Maine, Georgia, Minnesota, and Michigan (Exelon 2006).

Due to uncertainties associated with obtaining sufficient wood and wood waste to fuel a base-load generating facility, ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), relatively low energy-conversion efficiency, and potential air pollution from emission, the staff concludes that wood waste combustion is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.6 Municipal Solid Waste

Municipal waste combustors incinerate waste and use the resultant heat to generate steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent (EPA 2001). The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities (NRC 1996).

Growth in the municipal waste-combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. Increasingly, these plants have come under increasingly stringent environmental regulations that increased the capital cost necessary to construct and maintain the combustion facilities (DOE/EIA 2001b).

Estimates in the GEIS for License Renewal were that the overall level of construction impacts from a waste-fired plant are on the order of those incurred in building a coal-fired plant (NRC 1996). In addition, the operation of waste-fired plants have the same or greater environmental impacts as coal-fired plants, including air and waste disposal impacts of the ash.

Based on the above considerations, the staff concludes that generating electricity from municipal solid waste would not be a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.7 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators, including crops, crops converted to a liquid fuel such as ethanol, and crops (including wood waste) that have been converted to a gas. As discussed in the GEIS for License Renewal, none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as a new nuclear unit at the ESP site (NRC 1996).

The GEIS for License Renewal (NRC 1996) further suggests that the overall level of construction impacts from a crop-fired plant would be approximately the same as those of a wood-waste-fired plant. Crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air). In addition, these systems have large impacts on land use, due to the acreage needed to grow the energy crops. Exelon concludes that, due to the high costs and lack of obvious environmental advantage, burning other biomass-derived fuels is not a reasonable alternative.

The staff reviewed Exelon's assumptions and analysis and finds their conclusions reasonable. The staff concludes that converting biomass-derived fuels to energy is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.8 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and separating the two by an electrolyte. The only by-products are heat, water, and carbon dioxide.

Phosphoric acid fuel cells are generally considered first-generation technology and are commercially available at a cost of approximately $4500 per kW of installed capacity (DOE 2002). Higher-temperature, second-generation fuel cells achieve higher fuel-to-electricity ratios and thermal efficiencies.

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow (DOE 2004). Today, the most widely marketed fuel cells cost about $4500 per kWh of installed capacity. By contrast, a diesel generator costs $800 to $1500 per kWh of installed capacity, and a natural gas turbine can cost even less (DOE 2004).

DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell cost. DOE's goal is to cut costs to as low as $400 per kWh of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application (DOE 2004).

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50- to 100-MW range are projected to become available. The staff concludes that, at the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.9 Oil-Fired Generation

The EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States through the year 2020 because of higher fuel costs and lower efficiencies (DOE/EIA 2001c). Illinois, for example, has several oil-fired units, producing less than

1 percent of the State's electricity. The cost of an oil-fired operation is much higher than that of nuclear or coal-fired power generation. As a result, from 1997 to 1998, production of electricity by oil-fired plants dropped by about 40 percent in Illinois (DOE/EIA 1998). In the GEIS for License Renewal, the staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 49 ha (120 ac) (NRC 1996). Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. On these bases, the staff concludes that oil-fired generation is not a reasonable alternative to a new nuclear unit at the ESP site.

8.2.3.10 Combination of Alternatives

Individual alternatives to the construction of a new nuclear unit at the Exelon ESP site might not be sufficient on their own to generate Exelon's target capacity because of the small size of the resource or lack of cost-effective opportunities. Nevertheless, it is conceivable that a combination of alternatives might be cost-effective. There are many possible combinations of alternatives.

Section 8.2.2.2 assumes the construction of four 550 MW(e) natural gas combined-cycle generating units at the ESP site. As a reasonable combined alternatives option, the staff assessed the environmental impacts assuming a combination of three 550 MW(e) natural gas combined-cycle generating units at the site; 60 MW(e) of wind energy, hydropower, or pumped storage; 90 MW(e) from biomass sources, including municipal solid waste; and 400 MW(e) from purchased power, conservation and demand-side management. The impacts associated with the combined-cycle natural-gas-fired units would be the same as shown in Table 8-2 with magnitudes scaled for reduction in capacity from 2200 MW(e) to 1650 MW(e). While the demand-side management measures would have few environmental impacts, operation of the new natural gas-fired plant would result in increased emissions and other environmental impacts. The environmental impacts associated with power purchased from other generators would still occur, but would be located elsewhere within the region or the Nation or in another country. A summary of the environmental impacts of this combination of alternatives is given in Table 8-3.

8.2.4 Evaluation of Alternative Energy Sources and Systems

This section evaluates the environmental impacts from what Exelon has determined to be reasonable alternatives to a new nuclear unit at the ESP site: coal-fired generation and natural-gas-fired generation. The NRC staff evaluated Exelon's approach and analysis and finds that its findings and approach are reasonable. The environmental impacts of constructing and

Table 8-3. Summary of Environmental Impacts of a Combination of Power Sources - 2200 MW(e)

Impact Category	Impact	Comment
Air Quality	SMALL to MODERATE	SO_x: 121 MT (133 tons) per year NO_x: 387 MT (426 tons) per year CO: 82 MT (90 tons) per year TSP: all PM_{10}: 68 MT (75 tons) per year Some hazardous air pollutants.[(a)]
Waste Management	SMALL	28 m^3 of spent catalyst would be regenerated or would require disposal.[(b)]
Human Health	SMALL	Health effects would not be detectable if technology met regulatory controls.
Land Use	SMALL	Power block, offices, roads, and parking areas would use previously disturbed land at the ESP site. Additional land might be needed for infrastructure and other facilities.
Ecology	SMALL to MODERATE	Construction of a new cooling-water system. Potential impacts from transmission; limited habitat loss and fragmentation; limited impact to productivity and biological diversity; limited impact from bird strikes on wind turbines; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to LARGE	Impacts would depend on volume of water withdrawal and discharge, the constituents in the discharge water, and the characteristics of the surface-water body. Discharge of cooling tower blowdown would have impacts if cooling towers were built.
Socioeconomic	SMALL (Adverse) to LARGE (Beneficial)	Impacts from limited number of people (less than 80) to operate facilities would be absorbed easily across the region. Property tax impacts to DeWitt County would have a significant beneficial impact. Construction worker impacts would be temporary.
Aesthetics	MODERATE	ESP site is zoned industrial and located in a rural area. Existing operating nuclear facility onsite. Construction impacts minimized through use of best management practices. Wind turbines have limited noise impacts. Viewshed would have permanent impacts from physical structures and plumes.
Historic and Cultural Resources	SMALL	Any potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built on previously disturbed ground. Impacts to offsite properties could be mitigated by inventory, identification and recovery techniques.
Environmental Justice	SMALL	No evidence of environmental justice issues around the ESP site.

(a) Impacts are principally from natural gas power generation. Municipal solid waste or biomass facilities may generate some additional emissions.
(b) Impacts are principally from natural gas power generation. Municipal solid waste or biomass facilities may generate some additional waste.

operating a new nuclear unit at the ESP site and the alternative energy sources of coal- and natural gas-fired power generation at the same site, and a combination of power alternatives are summarized in Table 8-4.

When compared to the viable energy alternatives, a new nuclear unit at the ESP site is either environmentally equivalent or preferable to either coal-fired or natural gas-fired power generation, or a reasonable combination of power generation alternatives. A new nuclear unit at the ESP site is preferable to coal-fired power generation in the areas of air resources, waste management, land resources, ecological resources, water resources, and aesthetics. A new nuclear unit at the ESP site is preferable to natural gas-fired power generation and the combination of alternatives in the areas of air resources, ecological resources, water resources, and aesthetics.

Based on this analysis, the staff concludes that none of the economically viable alternative energy-generating technologies is environmentally preferable to a new nuclear unit at the ESP site.

Table 8-4. Comparison of Environmental Impacts of Alternative Energy Sources to a New Nuclear Unit

Impact Category	Nuclear	Coal	Natural Gas	Combination
Air quality	SMALL	MODERATE to LARGE	SMALL to MODERATE	SMALL to MODERATE
Waste management	SMALL	MODERATE	SMALL	SMALL
Human health	SMALL	SMALL	SMALL	SMALL
Land use	SMALL	MODERATE	SMALL	SMALL
Ecology (including threatened or endangered species)	SMALL to LARGE	MODERATE to LARGE	SMALL to MODERATE	SMALL to MODERATE
Water use and quality	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Socioeconomic	SMALL (Adverse) to LARGE (Beneficial)	SMALL (Adverse) to LARGE (Beneficial)	SMALL (Adverse) to LARGE (Beneficial)	SMALL (Adverse) to LARGE (Beneficial)
Aesthetics	SMALL	MODERATE	MODERATE	MODERATE
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL

8.3 System Design Alternatives

The purpose of the plant cooling system is to dissipate energy to the environment. The various cooling system options differ in how the energy transfer takes place and, therefore, have different environmental impacts. Sections 8.3.1, 8.3.2, and 8.3.3 contain information regarding alternative closed-cycle plant cooling systems for a new nuclear unit. Once-through cooling does not use cooling towers. Because of the 2001 EPA final rule on cooling water intake structures for new facilities (66 FR 65255), it is unlikely that new nuclear power facilities will employ once-through cooling. Section 8.3.1 discusses wet cooling tower heat dissipation systems, Section 8.3.2 hybrid wet/dry cooling tower heat dissipation systems, and Section 8.3.3 dry cooling towers' heat dissipation systems.

Exelon (2006) proposes the use of all three types of systems but states that full wet or hybrid wet/dry cooling processes have been assumed for most purposes because, of the range of options proposed, they have the greatest consumptive water use. Exelon does not provide information on a dry cooling system to support an environmental assessment nor does the applicant address the adverse environmental impacts of such a system (noise, large footprint, and inefficiency). Therefore, the staff did not perform a detailed site-specific evaluation of a dry cooling system during its review. The specific cooling system design for a new nuclear unit at the Exelon ESP site has not been selected; therefore, system design alternatives would be discussed at the CP or COL stage if an application were submitted to build a new plant at the site.

8.3.1 Plant Cooling System: Wet Cooling Towers

Wet cooling towers (mechanical or natural draft) systems transfer energy to the atmosphere via evaporation. This design results in a consumptive loss of about 2.0 m^3/s (70 cfs) of water because the majority of the rejected heat is dissipated through the conversion of liquid water to atmospheric water vapor. A consumptive loss of about 2.0 m^3/s (70 cfs) from Clinton Lake's water budget would result in reduced downstream flows and lower lake elevations during dry periods. While not discharging significant amounts of heat as blowdown to the lake, by decreasing the volume of water available in the lake to assimilate and dissipate the rejected heat in the once-through discharge from the existing CPS unit, a new nuclear unit would also contribute to higher temperatures in Clinton Lake. These higher temperatures, in turn, would contribute to greater induced evaporation.

8.3.2 Plant Cooling System: Hybrid Wet/Dry Cooling Towers

A hybrid wet/dry cooling system uses dry cooling to reduce evaporative losses associated with a wet cooling tower. Exelon did not include bounds for a hybrid wet/dry cooling system design in the plant parameter envelope (PPE). Therefore, the staff assumed that a hybrid wet/dry design would be bounded by the combined maximum values of the wet and dry cooling towers. This assumption would need to be validated at the COL stage if Exelon were to proceed with a hybrid wet/dry design at that time.

8.3.3 Plant Cooling System: Dry Cooling Towers

The use of dry cooling towers would largely eliminate the impacts on the lake and the aquatic ecosystem from a new nuclear unit. The lake would not be heated by rejected heat from that unit, and there would be no additional consumptive water use.

A dry cooling tower heat dissipation system reduces water-related impacts of operating, but it also has disadvantages. In particular, dry cooling systems are not as efficient as wet systems. They require movement of a large amount of air through the heat exchanger to achieve the necessary cooling. The fans that force the air through the heat exchanger use a significant amount of power. This power reduces the net power output of the facility. In addition, the fans and the large volume of air required for cooling make dry cooling towers noisy. Exelon did not provide information on dry cooling towers. Therefore, staff did not make a site-specific evaluation on the impacts of dry cooling.

8.4 Region of Interest and Site-Selection Process

NRC regulations require that the ER submitted in conjunction with an application for an ESP include an evaluation of alternative sites to determine whether there is any obviously superior alternative to the site proposed (10 CFR 52.17(a)(2)). This section includes subsections discussing Exelon's ROI for selecting alternative sites and its alternative site-selection process. The alternative sites considered in this EIS are six other nuclear power plant sites in Illinois.

8.4.1 Exelon's Region of Interest

The ROI is the geographical area considered in searching for candidate sites. Before deregulation of the power industry, the ROI for a utility typically would have been the state in which the proposed site was located or its service area. However, Exelon's proposal involves siting a merchant plant that would sell generated power in a deregulated marketplace. Exelon defines its ROI to be the State of Illinois on the basis of current deregulation policies, the availability of transmission facilities in the state, market flexibility, and the proximity of Exelon's customer base (Exelon 2006). The NRC staff considers Exelon's definition of its ROI to be reasonable.

8.4.2 Exelon's Alternative Site-Selection Process

Candidate sites are those sites within the ROI that are considered to be among the best sites that can be reasonably identified and made available for the siting of a nuclear power plant. Alternative sites are those that are specifically compared to the proposed site to determine if there is an obviously superior site. Existing nuclear power plant sites, greenfield sites, and brownfield sites within the ROI were all considered by Exelon as candidates. The candidate-site criteria presented in NUREG-1555 (NRC 2000) were used to select the alternative sites from among the candidate sites. The alternative sites selected were: Braidwood Generating Station, Byron Generation Station, Dresden Generating Station, LaSalle County Station, Quad Cities Generating Station, and Zion Generating Station. The locations of these sites are shown in Figure 8-1.

Exelon undertook a site-by-site comparison of alternative sites with the proposed site in the ER to "determine if there are any alternative sites that are environmentally preferable to the proposed site." Their review process involved the two-part sequential test outlined in NUREG-1555 (NRC 2000). The first stage of the review uses reconnaissance-level information to determine whether there are environmentally preferable sites among the alternatives. If environmentally preferable sites are identified, the second stage of the review considers economics, technology, and institutional factors for the environmentally preferred sites to see if any is obviously superior to the proposed site.

Exelon developed a two-phase, three-step process for reviewing the sites. This process is outlined below.

- Step 1 – *Identify the alternative sites*. The proposed site is co-located with an existing nuclear facility (Clinton Power Station). Therefore, Exelon chose its other nuclear facilities within the ROI as alternative sites. Thus, there are six alternative sites to Clinton, each co-located with an existing nuclear facility site. In addition, Exelon considered a generic greenfield site and brownfield sites.

- Step 2a – *Consider sites without existing nuclear facilities*. The initial step was evaluation of undeveloped greenfield and brownfield sites. The impacts of building on a greenfield site would be greater than building at an existing site with a nuclear facility (disturbing land that had not previously been disturbed). Therefore, greenfield sites were determined not to be environmentally preferable to the proposed site. Most brownfield sites in the ROI are not large enough to meet the size requirements for a new nuclear plant: 200 to 400 ha (500 to 1000 ac). Exelon concluded that the environmental impacts from building on a brownfield site would be greater than or equal to those at the proposed ESP site (Exelon 2004a).

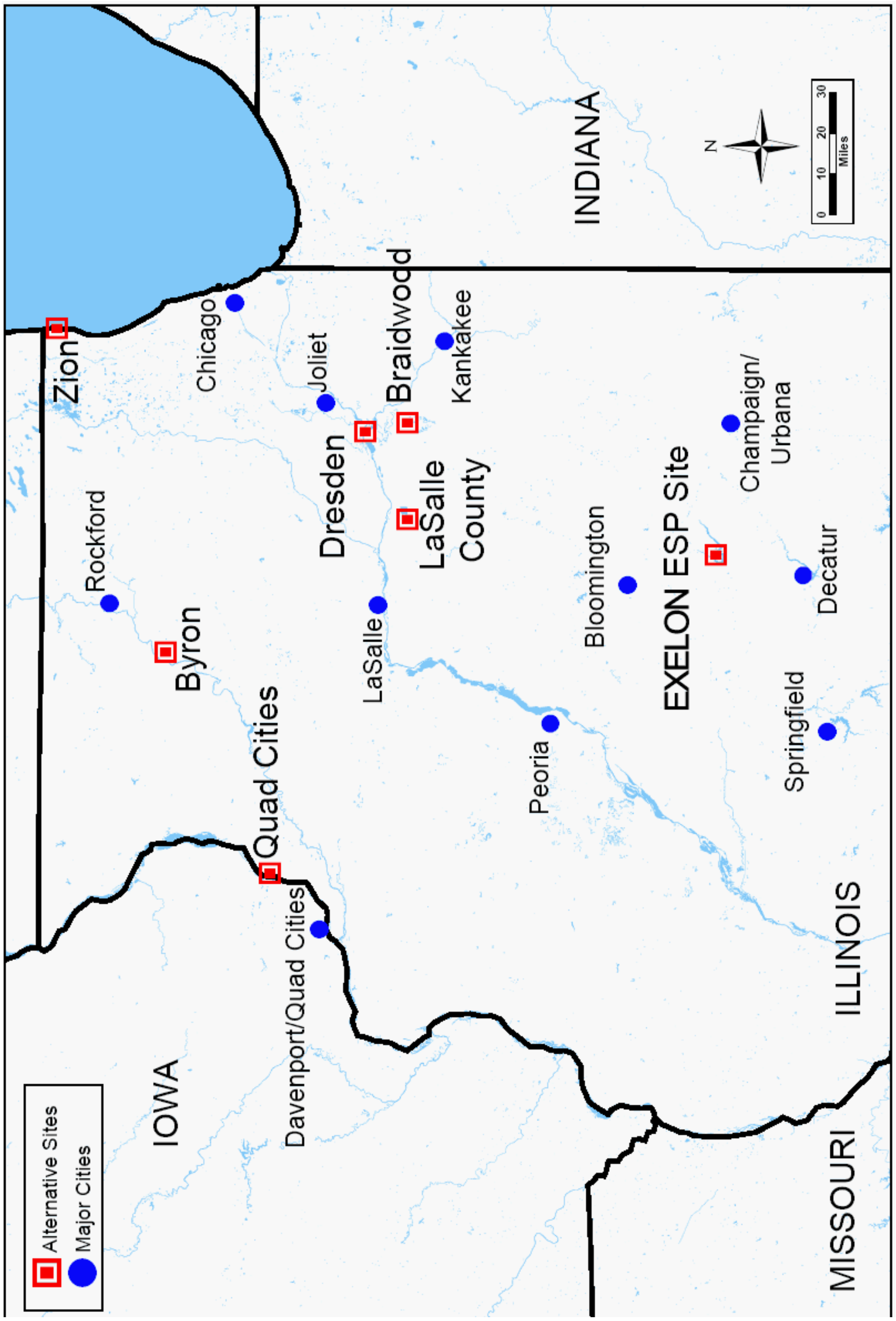

Figure 8-1. Sites Considered by Exelon for an Early Site Permit

- Step 2b – *Consider sites with existing nuclear facilities*. The next step was evaluation of sites with an existing nuclear facility to determine if the sites met the minimum land requirements specified in the plant parameter envelope (PPE), set forth in the ESP application (Exelon 2006). If additional land would be required, Exelon assumed that the environmental impacts of developing a new nuclear facility would be similar to the impacts for developing a previously undeveloped site. Alternative sites with an existing facility but with insufficient land were deemed “not environmentally preferable” to the proposed site and excluded from further analysis (Exelon 2004a). Exelon relied on NUREG-1437 (NRC 1996) as a basis of defining land requirements for building a new nuclear unit at the ESP site and used these land requirements as one basis for eliminating three of the six alternative sites with nuclear facilities (Byron, Quad Cities, and Dresden). Although Exelon eliminated three of the alternative sites, the staff considered all six sites in its review.

- Step 3 – *Compare remaining alternative sites with proposed ESP site.* The environmental impacts of siting a new nuclear unit at remaining alternative sites were compared against the impacts for siting a new unit at the proposed site. The comparisons made using the candidate site criteria and reconnaissance-level information did not indicate that the alternative sites were environmentally preferable. Exelon did not identify any environmentally preferable site in its evaluation process. Therefore, Exelon did not continue the evaluation process.

In its ER, Exelon summarized the advantages of the proposed ESP site over the alternative sites as follows:

- The postulated consumptive use of water by a new unit at the proposed ESP site would be no greater than water use at the alternative sites.

- The proposed ESP site does not contain any critical habitat for or occurrence of listed, threatened, or endangered species. Therefore, impacts of development of a new unit at the proposed site on endangered species would be no greater than impacts postulated for the alternative sites.

- The proposed ESP site does not contain spawning grounds for any threatened or endangered species. Thus, the impacts on spawning areas would be no greater than impacts at the alternative sites.

- The proposed ESP site impact review does not postulate effluent discharge beyond the limits of existing National Pollutant Discharge Elimination System (NPDES) permits or regulations. Based on the information available for the alternative sites, the impacts from effluent discharge at the proposed site would be no greater than impacts at the alternative sites.

- The siting of a new unit at the proposed ESP site would not require preemption or land-use changes for construction and operation. Therefore, land-use impacts at the proposed site would be no greater than the impacts at the alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the proposed ESP site would be no greater than the impacts at the alternative sites.
- The proposed ESP site is in a rural setting and has a population density that meets the population criteria of 10 CFR Part 100.
- The ESP site does not require decommissioning or dismantlement of an existing facility, as would be required for the Byron, Quad Cities, and Dresden alternative sites (Exelon 2004a).

On the basis of its review, Exelon concluded that the proposed ESP site is the environmentally preferred candidate site, so the applicant stopped its alternative site evaluation and did not go on to the second stage of the two-part sequential test.

The NRC staff reviewed the methodology used by Exelon for selecting and evaluating the alternative sites and considers Exelon's methodology to be reasonable. The NRC staff also concludes that the Exelon findings of LARGE and MODERATE significance levels for certain environmental impacts at greenfield and brownfield sites, respectively, are reasonable.

8.5 Evaluation of Alternative Sites

The staff reviewed Exelon's findings for each of the alternative sites, visited each of these sites, and collected additional reconnaissance-level information about the sites. The following sections present the results of the staff's review and evaluation of the information.

8.5.1 Dresden Generating Station

The Dresden Generating Station is located in Goose Lake Township, Grundy County, Illinois, on the south shoreline of the Illinois River at the confluence of the Des Plaines and Kankakee Rivers (immediately below the junction of the Kankakee and Des Plaines Rivers at River Mile 272.4) (Exelon 2002a).

The Dresden site consists of approximately 1000 ha (2500 ac) owned by Exelon with an additional 0.4 ha (1 ac) of river frontage leased from the State of Illinois. In addition to the two operating nuclear reactors and their turbine building, intake and discharge canals, cooling pond and canals, and auxiliary buildings, the site includes switchyards and Dresden Unit 1 (permanently ceased operation on August 31, 1984) (Exelon 2002a).

The station uses once-through cooling with the Illinois River as the source and receiving water. The station also has a cooling canal and cooling pond to reduce the heat load in the river during periods of high water temperature.

No major metropolitan areas exist within 10 km (6 mi) of the Dresden site. The nearest town is Channahon, approximately 5 km (3 mi) northeast of the site. The site is approximately 13 km (8 mi) east of Morris, Illinois; 24 km (15 mi) southwest of Joliet, Illinois; and 80 km (50 mi) southwest of downtown Chicago. The area within 10 km (6 mi) of the site includes parts of both Grundy and Will Counties.

8.5.1.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Portions of the site outside the Dresden station footprint have been leased to a neighboring farmer for grazing cattle and raising crops. Hunting is also permitted outside security areas. Current land use is industrial. Given the fact that the entire Dresden site has been a large power-generating facility since 1965, the current land use would not be expected to change with construction of a new nuclear unit at the Dresden site (Exelon 2006).

The local terrain is level to gently undulating, except for the Kankakee Bluffs just northeast of Dresden on the north bank of the Illinois River. The area around Dresden is largely rural, characterized by farmland, woods, and small residential communities. The area around Dresden has become increasingly urbanized, and it is expected that the trend will continue. The construction and operation of a new nuclear unit at the site would not be expected to affect the land-use patterns of the area (Exelon 2006).

In its ER, Exelon states that the Dresden site does not have additional available land within its boundaries to build a new nuclear unit. To build a new nuclear unit, an operating unit or Unit 1 would need to be decommissioned and dismantled so that the new nuclear unit could be constructed on the decommissioned unit footprint (Exelon 2006).

Overall, the land-use factors of construction and operation of a new nuclear unit are not particularly site-dependent. The staff visited the Dresden site on March 9, 2004. The footprint of the new nuclear unit would be about 41 ha (100 ac) (Exelon 2006) and, based on observation of the site, the staff believes that a new unit could be configured to fit within previously disturbed land on the existing 1000-ha (2500-ac) Dresden site. On this basis, the staff concludes that land-use impacts associated with site-preparation and construction, or resulting from operation of a new nuclear unit, at the Dresden site would be SMALL.

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in determination of environment preferability. Therefore these impacts are discussed generically in Section 8.6.1.

Seven transmission line rights-of-way, spanning 353 km (220.5 mi) and covering about 2440 ha (6030 ac), connect Dresden Units 2 and 3 to the electric grid (NRC 2004b). Although not stated by Exelon, the staff assumed that the existing transmission lines serving Dresden do not have the capacity to carry the power that would be generated by a new nuclear unit. The procedures for adding the new transmission lines that would be required to connect a new nuclear unit at the Dresden site to the transmission grid are similar to those described in Section 3.3. They involve both the power provider and the transmission provider, with the transmission provider having the ultimate responsibility for determining the nature of modifications to the existing transmission system to accommodate the additional load. It is likely that new transmission lines, and possibly additional rights-of-way, would be needed. The additional transmission lines could be installed via expansion of existing rights-of-way, which the staff believes to be the likely scenario, or they could follow a new right-of-way. The staff assumes that any transmission system modifications would be expansions of existing rights-of-way. For reasons similar to those discussed in Chapters 4 and 5 related to expansion of the rights-of-way for the Exelon ESP site, the staff concludes that the land-use impacts of transmission-line rights-of-way expansion would be SMALL.

8.5.1.2 Hydrology, Water Use, and Water Quality

The staff assumed that a new nuclear unit at Dresden would withdraw makeup water from the Illinois River. It would use wet cooling towers for station cooling. The staff estimated the 7Q10 (7-day average minimum annual flow) and 30Q2 (median 30-day minimum annual discharge) based on data from the U.S. Geological Survey (USGS) stream gauge 05543500 (Illinois River at Marseilles, Illinois). Data for the period of record from 1919 through 2003 were used to estimate the 7Q10 and 30Q2 values. This gauge is slightly downstream of Dresden. The drainage area upstream of the gauge that is near the site was reported by the USGS to be 21,391 km^2 (8259 mi^2). The 7Q10 and 30Q2 values estimated by staff are 75 m^3/s (2661 cfs) and 111 m^3/s (3911 cfs), respectively. The net consumptive loss for a wet cooling tower, based on the PPE, is 2.0 m^3/s (70 cfs) or 2.6 and 1.8 percent of the Illinois River 7Q10 and 30Q2, respectively. Wet towers were used as the basis of the assessment because wet towers represent the greatest consumptive loss of water.

Any releases of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality is protected.

Based on the requirements of the NPDES permit and the above analysis, the staff concludes that the water-use and water quality impacts of an additional unit at the Dresden site would be SMALL.

8.5.1.3 Terrestrial Resources Including Endangered Species

The Dresden site occupies approximately 1000 ha (2470 ac). Undeveloped areas are located mostly on the western half of the site and support a mosaic of habitats, including old fields, wetlands, and woodland vegetation (NRC 2004b).

The seven transmission lines that currently serve Dresden traverse primarily farmland but also cross a small amount of forest and four natural terrestrial habitat areas: Goose Lake Prairie State Natural Area (containing tall grass prairie and marshes), Des Plaines Fish and Wildlife Area (containing river shorelines, lakes, swamps, marshes, and prairie), Midewin National Tallgrass Prairie (previously disturbed, with plans to restore tallgrass prairie vegetation), and Heidecke Lake State Fish and Wildlife Area (cooling lake area leased to Illinois Department of Natural Resources [IDNR] for hunting and fishing) (NRC 2004b). It is assumed that the seven existing transmission lines do not have the capacity to carry the power that would be generated by a new unit at the Dresden site, and it is likely that new transmission lines, and thus expanded rights-of-way would be needed.

There are 30 State-listed threatened or endangered terrestrial species known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Dresden site, and 14 that occur within 3.2 km (2 mi) (IDNR 2004c).

Construction Impacts

It is assumed that structures for a new nuclear unit at the Dresden site (power block structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers) would be constructed in developed areas on the eastern half of the Dresden site and in old field areas, where possible, and would minimally impact woodlands and wetlands. Consequently, terrestrial ecological impacts from construction of a new unit at the Dresden site would be minimal.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would be expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Terrestrial ecological impacts associated with the upgrade could range from minor to extensive, depending on potential impacts to Goose Lake Prairie State Natural Area, Des Plaines Fish and Wildlife Area, Midewin National Tallgrass Prairie, and Heidecke Lake State Fish and Wildlife Area.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial resources from construction of a new nuclear unit at the Dresden site and construction associated with possible upgrade of the existing Dresden transmission system could range from SMALL to LARGE.

Operational Impacts

Impacts on terrestrial ecological resources from operation a new nuclear unit at the Dresden site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites, and thus cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There are nine Federally listed threatened or endangered terrestrial species that may occur in the vicinity of the Dresden site or its transmission lines: the endangered Indiana bat (*Myotis sodalis*), the threatened bald eagle (*Haliaeetus leucocephalus*), the endangered Hine's emerald dragonfly (*Somatochlora hineana*), the endangered leafy prairie clover (*Dalea foliosa*), the threatened lakeside daisy (*Hymenoxys herbacea*), the threatened eastern prairie fringed orchid (*Platanthera leucophaea*), the threatened prairie bush clover (*Lespedeza leptstachya*), the threatened Mead's milkweed (*Asclepias meadii*), and the threatened decurrent false aster (*Boltonia decurrens*) (NRC 2004b; FWS 2004a). Of these nine species, designated critical habitat exists only for the Indiana bat (NRC 2004b; FWS 1976, 2004a). There is also one Federal candidate species that may occur in the vicinity of the Dresden site or its transmission lines, the eastern massasauga (rattlesnake) (*Sistrurus catenatus*) (NRC 2004b).

The 10 Federally protected or candidate species listed above are known to occur in counties traversed by the transmission lines (NRC 2004b). These species are associated with prairie, wetland, or open water habitats and could occur along portions of the transmission line rights-of-way where suitable habitat is present (NRC 2004b). Six of these Federally protected or candidate species could also occur on the undeveloped portion of the Dresden site: bald eagle, Indiana bat, eastern prairie fringed orchid, Mead's milkweed, prairie bush clover, and eastern massasauga (FWS 2004a).

The bald eagle is known to winter along large rivers, lakes, and reservoirs in Grundy County. However, no night roost sites are known to occur there (FWS 2004a). The bald eagle is likely to occur at least occasionally in the vicinity of the Dresden site as a winter visitor to the Illinois River, Heideke Lake, or the Dresden cooling pond (NRC 2004b).

The Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004a). Its occurrence on the Dresden site is considered possible (NRC 2004b). The only designated critical habitat for the Indiana bat in Illinois is the Blackball Mine in LaSalle County (FWS 1976).

The eastern prairie fringed orchid is known to occur in Grundy County (FWS 2004a), within 3.2 to 16 km (2 to 10 mi) of the Dresden site (IDNR 2004c). The eastern prairie fringed orchid prefers mesic to wet prairie habitat and potentially occurs throughout Illinois. It occurs in tallgrass silt-loam or sand prairies, sedge meadows, fens, and occasionally sphagnum bogs (FWS 1999). It appears to be adapted to disturbance and occasionally colonizes early succession habitats or recolonizes previously occupied areas (NRC 2004b). Although no populations of eastern prairie fringed orchid are known from the project area, it is possible that undeveloped portions of the Dresden site and associated transmission line rights-of-way could support this species (NRC 2004b).

The primary habitat of Mead's milkweed is mesic to dry mesic, upland tallgrass prairie. Although no populations of Mead's milkweed are known from the project area, it is possible that undeveloped portions of the Dresden site and associated transmission line rights-of-way could support this species (NRC 2004b).

The prairie bush clover occurs on dry gravel and sand prairies and is rare throughout its range. Although no populations of the prairie bush clover are known to occur in the project area, it is possible that undeveloped portions of the Dresden site and associated transmission line rights-of-way could support the species (NRC 2004b).

The eastern massasauga is usually found in or near wet areas including wetlands, wet prairie, and nearby woodland or shrub habitat. The species also uses dry old fields with goldenrod (*Solidago* spp.) and woody species, such as dogwood (*Cornus* spp.) or multiflora rose (*Rosa multiflora*). Dry upland areas up to 2.4 km (1.5 mi) away from wet habitat are used during the summer (NRC 2004b). Although the eastern massasauga is not known to occur in the project area, undeveloped portions of the Dresden site and associated transmission line rights-of-way could support the species.

Because these six Federally protected or candidate species could occur on the Dresden site and along the associated transmission line rights-of-way, impacts to these species from construction of a new nuclear unit at the Dresden site and possible expansion of the transmission line rights-of-way could range from minor to extensive (NRC 2004b).

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that impacts on threatened or endangered species from construction of a new nuclear unit at the Dresden site and construction associated with possible upgrade of the existing Dresden transmission system could range from SMALL to LARGE.

8.5.1.4 Aquatic Resources Including Endangered Species

The Dresden facility draws water from the Kankakee River and discharges into the Illinois River (Exelon 2006). Fish sampling conducted during 2001 in the Dresden Pool and downstream of the Dresden Island Lock and Dam yielded 54 fish species and two hybrids. Numerically, the catch was dominated by gizzard shad (*Dorosoma cepedianum)*, emerald shiner (*Notropis atherenoides*), bluegill (*Lepomis macrochirus*), spotfin shiner (*Notropis spilopterus*), bluntnose minnow (*Pimephales notatus*), and bullhead minnow (*Pimephales vigilax)* (NRC 2004b). Other species present in significant numbers (greater than 1 percent of the sample) included green sunfish (*Lepomis cyanellus*), spottail shiner (*Notropis hudsonius)*, largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), sand shiner (*Notropis stramineus*), threadfin shad (*Dorosoma petenense*), freshwater drum (*Aplodinotus grunniens*), common carp (*Cyprinus carpio*), and golden redhorse (*Moxostoma erythrurum*) (NRC 2004b). Benthic community studies of the Dresden Pool conducted in 1999 and 2001 found that the benthic community was poor and dominated by tolerant and facultative taxa, such as Oligochaeta (aquatic worms) and Chironomidae (midge larvae) (NRC 2004b). The non-indigenous Asiatic clam (*Corbicula fluminea*) is found in the Kankakee River in the vicinity of the site (USGS 2004), and the zebra mussel (*Dreissena polymorpha*) began infesting the Dresden cooling pond in 1991 (NRC 2004b). The round goby (*Neogobius melanostomus*) is another invasive species found in the vicinity of the Dresden site (NRC 2004b).

Construction Impacts

The construction of both a cooling water intake structure and discharge might be necessary if a new nuclear unit was built at the Dresden site. While aquatic biota, including recreational sport fish, would be temporarily displaced during the construction period, they would be expected to recolonize the area after construction was complete. It is expected that the disturbance to aquatic resources from construction would be localized and of relatively short duration. The NRC staff has reviewed the information provided by Exelon and visited the Dresden site and concludes that the environmental impacts of construction of a new nuclear unit at the Dresden site on aquatic resources would be SMALL.

Operation Impacts

With respect to operation of a new nuclear unit at the Dresden site, the ecology of the area surrounding the Dresden cooling pond and the intake and discharge structures has been studied extensively since the late 1960s. Studies of the lower trophic levels (phytoplankton, zooplankton, periphyton, and benthic invertebrates) and the fish community indicate that operation of the existing Dresden nuclear units has not had a measurable detrimental impact on the ecology of the Illinois River system.

In addition, impingement sampling was conducted at the traveling intake screens at the operating Dresden nuclear units from 1977 to 1987. The study concluded that the number of fish impinged at Dresden was low and that the fish in the adjacent river system were not being adversely impacted by Dresden operations. Entrainment and impingement both occur as a result of operation of the intake of the existing units and would be expected to continue during the operations of a new nuclear unit at the Dresden site (Exelon 2006). However, any new nuclear unit at the Dresden ESP site would be required to meet the new EPA Phase I ruling, which is likely too require closed-cycle cooling. Operation of the new ESP unit utilizing closed-cycle cooling would withdraw substantially less water from the Illinois River than do Dresden units 2 and 3, resulting in significantly less impingement and entrainment loss.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the environmental impacts to aquatic ecosystems, from operation of a new nuclear unit at the Dresden site, would be SMALL.

Threatened or Endangered Species

No Federally listed aquatic plant or animal species have been found in the vicinity of the Dresden site (NRC 2004b). Three Illinois listed endangered or threatened species - the pallid shiner (*Notropis amnis*), the greater redhorse (*Moxostoma valenciennesi*), and the river redhorse (*Moxostoma carinatum*) - have been collected in low numbers near the Dresden site. The pallid shiner has only been collected downstream of Dresden Island Lock and Dam, and both redhorse species prefer a more complex channel substrate than is found near Dresden.

Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact on Federally listed threatened or endangered aquatic species from construction and operation of a new nuclear unit at the Dresden site would be SMALL.

8.5.1.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new nuclear unit at the Dresden site. The evaluation assesses impacts of construction and station operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of the construction and operation of a new nuclear unit are similar for each of the alternative sites. They are discussed generically in Section 8.6.4.

Demography

Dresden is in Grundy County, Illinois, adjacent to Will County and approximately 80 km (50 mi) southwest of Chicago. Both counties are components of the nine-county Chicago Primary Metropolitan Statistical Area, which boasted a regional 2000 population of 8,272,768 (based on the 2000 Census) and includes the City of Chicago (USCB 2000a). Grundy County has a total population of 37,575 and Will County 502,266 (USCB 2000b). As derived from Census Bureau information, 337,882 people live within 32 km (20 mi) of Dresden and 7,078,561 people live within 80 km (50 mi) (Exelon 2002a).

It is expected that most construction workers would come from within the region. Should a larger than expected number of construction workers decide to locate to Grundy County, there could be a noticeable increase in population, but it would not be excessive. If 20 percent of the construction workforce, or about 650 workers (without their families), decided to relocate temporarily to Grundy County or Will County, it would represent only a 1.7 and 0.19 percent increase in total population, respectively, based on 2000 Census data.

Some new jobs might result from the multiplier effect[(a)] attributable to the construction workforce and might result in some increase in population in the region. But these increases, when compared to the total population base in the region, would be minimal. Any multiplier effects resulting from construction worker expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity. Therefore, based on information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the demographic impact of construction of a new unit at Dresden would be SMALL.

Exelon employs a permanent workforce of approximately 870 workers and an additional 120 to 130 contract and matrixed employees at Dresden to operate two functioning reactors (Exelon 2002a). Approximately 580 additional permanent workers would be required for the operation of a new unit at Dresden (Exelon 2006). Exelon expects that most of the new operating workforce would come from within the region (Exelon 2006). But even if the 580 additional employees and their families were to come from outside the region, the potential increases in population of the most impacted counties would not be significant. For example, the 580 additional employees would translate into an increase in population of about 2320, assuming each new employee represented a family of four. The addition of the new employees and their families would equate to a population increase for Grundy County of 6.2 percent and for Will County of 0.69 percent (assuming all 2320 individuals located to one county or the other). Overall, the potential increases in population do not represent a large percentage increase in the total population for the most impacted counties. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the demographic impact of operation of a new unit at Dresden would be SMALL.

(a) In the multiplier effect, each dollar spent on goods and services by a construction worker becomes income to the recipient, who saves some but re-spends the rest on consumption. His re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier."

Impacts to the Community - Social and Economic

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the Dresden site. Some of the impacts of construction and operation of a new nuclear unit that are generic are discussed in Section 8.6.4.

Economy

Grundy County is one of Illinois's commercial and agricultural centers. Grundy County has a smaller economic base than Will County, which means that economic impacts such as construction of a new nuclear unit would have more of an impact than in neighboring Will County. While the County's agriculture sector ranks high in production relative to other Illinois counties, it ranks relatively low in employment when compared to the County's other major industries (Exelon 2002a). As of 2001, Grundy County's industrial profile was led by retail trade (17 percent), manufacturing (14 percent), health care and social assistance (12 percent), and accommodation and food services (11 percent) (USCB 2001a).

In the late 1800s, Will County's prairie soil, soft coal, and river access spurred the emergence of a steel and manufacturing industry. When the steel industry eventually waned, the County embraced a broader base of industrial and commercial enterprise (CPN 2004). Today, Will County's dominant industries are manufacturing (18 percent), retail trade (13 percent), construction (11 percent), and health care and social services (9 percent) (USCB 2001b).

The annualized unemployment rate for the State of Illinois in 2000 was 4.3 percent. In comparison, Will and Grundy Counties had year-2000 unemployment rates of 5.2 and 4.1 percent, respectively (IDES 2000a and 2000b).

Based on the information provided by Exelon and the NRC staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and station operation on the economy of the region would be SMALL everywhere in the region except Grundy County, where the impacts could be MODERATE.

Taxes

Corporate and personal income taxes and sales and use taxes would be collected during both the construction and operation of a new unit at the Dresden site. Property taxes would be collected during construction. Taxes collected as a result of constructing and operating a new unit at Dresden would be of benefit to the State and the local jurisdictions that collected and spent them. In absolute terms, the personal and corporate income, sales, and use taxes associated with construction and operation of a new nuclear unit would be large, but the total would be small when compared to the total amount of taxes Illinois collects annually. Based on information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the overall beneficial impacts of corporate and personal income, sales, use, and property taxes during construction would be SMALL.

Following the construction period and at the start of operation of a new nuclear unit, Dresden would pay annual property taxes to Grundy and Will Counties. For the years 1997 to 2000, the Dresden property taxes provided between 13 and 20 percent of Grundy County's total levy extension and between 13 and 21 percent of Grundy County's total collections available for distribution. For these years, Dresden's property taxes provided less than 1 percent of Will County's total levy. Exelon projects that the Dresden annual property taxes will change in the future due to deregulation of the electric utility industry in Illinois (see Section 2.8.2.2 for a discussion of deregulation) (Exelon 2002a). Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that impacts of a new nuclear unit on property tax collections during operation would be SMALL to MODERATE (depending on the impacts of deregulation) for Grundy County[a] and SMALL for Will County. In all cases, the tax impacts would be beneficial to the receiving counties.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the Dresden site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

Road access to Dresden is via Dresden Road, a two-lane paved road. Dresden Road intersects with Pine Bluff Road approximately 3.2 km (2 mi) south of the station. Continuing south for approximately 6.4 km (4 mi), Dresden Road ends at the Coal City limits. Most employees from Grundy and Will Counties travel on these roads to reach the Dresden Generating Station. The State of Illinois does not make level-of-service (LOS)[b] determinations in rural, non-metropolitan areas such as Dresden unless it is deemed necessary. Neither Dresden Road nor Pine Bluff Road has had an LOS determination calculated by the Illinois Department of Transportation (Exelon 2002a).

(a) Given the facility's potential value and property taxes paid to Grundy County, the staff assumed that the facility's impact on collected property taxes would, at a minimum, be SMALL and could be MODERATE when compared to the taxes the facility could pay and the total property taxes collected by the county.

(b) LOS defines the flow of traffic on a designated highway. LOS designations can range from traffic freely flowing to a point where traffic flow exceeds the design capacity of the highway resulting in severe congestion.

A daily average of approximately 4050 cars traveled Dresden Road from the plant to Pine Bluff Road in 1996. The Dresden plant employs 1000 permanent and contract employees. During refueling operations approximately 760 temporary workers are employed over a two week period. Refueling is on a 24-month staggered cycle for each unit (Exelon 2002a). If each of the 3150 construction workers commuted alone to the Dresden site, this could put an additional 3150 cars on a two-lane highway, causing potential congestion during shift changes. Also, the traffic of hauling construction materials to the site could bring additional congestion to Dresden and Pine Bluff Roads during certain times of the day, particularly at shift changes.

With respect to the operations of the facility, adding an additional 580 cars and up to 760 cars during refueling outages (again assuming a single occupant per car) to the existing 4050 cars on the road would not materially congest the highway, except potentially at shift changes, which could be staggered between the two plants (Dresden and the new unit) so that the traffic increases would not occur at the same time.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction of a new nuclear unit at Dresden on transportation would be SMALL to MODERATE where some mitigation actions might need to be undertaken. Mitigation measures could include traffic control zones, staggered shift changes, and traffic control devices, among others. Construction could bring congestion to Dresden and Pine Bluff Roads. Based on the staff's independent review of reconnaissance level information, the staff concludes that the impacts on transportation of the operations workforce at the new unit at Dresden would be SMALL, and that mitigation would not be warranted.

Aesthetics and Recreation

The terrain of the Dresden site is relatively flat. Portions of the site are relatively open and clear of woods while other parts of the site have woods with trees of small diameter, indicating that at one time the site was logged. Light residential development is close to the site, including a house sitting just outside the main gate and three new houses going up around the cooling reservoir. There are several marinas located in the area on the rivers. Construction of a new unit at Dresden would be noticed by these close residents.

The local terrain is level to gently undulating, except for the Kankakee Bluffs just northeast of Dresden on the north bank of the Illinois River. The area around Dresden is largely rural, characterized by farmland, woods, and small residential communities (NRC 2004b). The Kankakee River supports a sports fishery. The Illinois River is used for commercial traffic such as barges.

A new nuclear unit at Dresden probably would have visual impacts similar to those of the existing Dresden facility. But the use/discharge by another unit of additional heated water to the cooling reservoir and the use of cooling towers could exacerbate fog conditions during adverse meteorological conditions, warranting some mitigation such as fog drift eliminators on the cooling towers. There could be additional impacts on aesthetic quality for nearby residences in the area as a result of the fog, even though the area is predominately in agricultural use.

Based on information provided by Exelon, the staff's independent review of reconnaissance-level information, and information collected during the site visit on March 4, 2004, the staff concludes that the aesthetic impacts of station construction and operation would be SMALL.

Housing

In Will County there are 175,524 housing units, of which 7982 are vacant (or approximately 5 percent); in Grundy County, there are 15,040 total housing units, of which 747 are vacant (5 percent) (USCB 2000b). A 5-percent vacancy rate would appear to indicate a potential shortage of housing for the construction workforce of 3150 and an operations workforce of up to 580. However, in an area that has a population of 7,078,561 within an 80-km (50-mi) radius of Dresden (Exelon 2002a) and, assuming the construction workforce would commute from all over the 80-km (50-mi) radius, there should not be discernable impacts on housing availability, rental rates, housing values, or the spurring of housing construction or conversion. There might be a shortage of housing if construction workers decided to locate in Will and Grundy Counties, but this would be unlikely if they were already located in the region. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on the availability of housing would be SMALL.

If built, a new nuclear unit at Dresden would have up to 580 employees when operational (Exelon 2006). Exelon assumes that the operating workforce would come from within the region. There would be minimal impacts on housing availability, rental rates, housing values, or the spurring of housing construction or conversion in such instance.

Of the current employees at Dresden, 72 percent live in Will and Grundy Counties (Exelon 2002a). If it is assumed that the new workforce would not come from within the region and that the new workforce would follow past practices, then approximately 400 of the new operating employees would locate in the two counties. There are no growth restrictions in either county. Depending on how the new employees split between the two counties, there could be small to moderate impacts on housing values and rents and a similar incentive for new construction. Based on the information provided by Exelon and staff independent review of reconnaissance-level information, the staff concludes that the impacts of station operation on the availability of housing would be SMALL in both Will and Grundy counties, if workers came from the region, to SMALL (Will County) to MODERATE (Grundy County), if workers relocate to the region. Mitigative measures would operate through market forces leading to construction of additional housing.

8.5.1.6 Historic and Cultural Resources

The impacts on historic and cultural resources of construction and operation of a new unit at Dresden and at the other alternative sites are discussed generically in Section 8.6.5.

8.5.1.7 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. Exelon followed NRC guidance (NRC 2001) in applying environmental justice criteria in its ER for license renewal of Dresden (Exelon 2002a). The NRC staff has reviewed the analysis using updated guidance (NRC 2004a; 69 FR 52040).

The 2000 Census and block groups were used for ascertaining environmental justice issues for minority populations for license renewal, and the 1990 Census and census tracts were used for low-income environmental justice issues. There are 5503 block groups within an 80-km (50 mi) radius of Dresden. Based on the “more than 20 percent” criterion, no Native Hawaiians or other Pacific Islanders live in the geographic area; American Indian or Alaskan Native minority populations exist in one block group; Asian minority populations exist in 83 block groups; and black minority populations exist in 1470 block groups “All Other Single Minorities” populations exist in 628 block groups; “Multi-racial” minority populations exist in 7 block groups; “Aggregate of Minority Races” populations exist in 2023 block groups; and “Hispanic Ethnicity” minority populations exist in 1004 block groups (Exelon 2002a). Data from the 2000 Census characterized 32.2 percent of the Illinois population and 14.2 percent of Indiana’s population as minority (USCB 2000a).

The Census Bureau data characterize 11.47 percent of Illinois households as low-income, while 10.78 percent of Indiana households are similarly classified. Based on the “more than 20 percent” criterion, 263 census tracts out of a possible 1693 contain a low-income population (Exelon 2002a).

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting these minority and low-income populations. Based on a review of the Dresden ER for license renewal, the staff’s independent review, and a visual reconnaissance during the site visit to Dresden (March 9, 2004), the staff concludes that environmental justice consequences of the construction and operation of a new nuclear unit at Dresden would be SMALL, and that mitigation would not be warranted.

8.5.2 Braidwood Generating Station

The Braidwood Generating Station is located on a site in the southwest corner of Will County, southwest of Joliet about 17 km (11 mi) southeast of the Dresden Generating Station. The site covers 1804 ha (4457 ac), of which the cooling pond occupies about 1027 ha (2537 ac). Braidwood is on the Kankakee plain, in a region characterized by abandoned strip coal mines. The site itself is located on a former strip mine (Exelon 2000; AEC 1974a). Braidwood was originally developed for four units. Two nuclear units are currently operating (Exelon 2006).

The site is approximately 5 km (3 mi) west of the Kankakee River at a point 22 km (14 mi) upstream from its confluence with the Des Plaines River. The Mazon River and its branches (East Fork, Reddick Run, Crane Creek, and Granary Creek) are to the west, southwest, and south of the site. The Mazon River passes within 1.6 km (1 mi) of the southwestern site boundary.

8.5.2.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

The terrain surrounding the site is flat. Despite its proximity to Joliet and Chicago, the area is not heavily industrialized and remains primarily agricultural. The Kankakee River is a popular recreational area and supports numerous sports such as fishing and hunting. No land would be preempted for additional facilities built at this station. Exelon states that Braidwood has sufficient land to construct a new unit at the site (Exelon 2006). The NRC staff visited the Braidwood site on March 9, 2004, and met with Exelon personnel.

Overall, the land-use factors of construction and operation of a new nuclear unit are not particularly site-dependent. The footprint of a new unit would be about 41 ha (100 ac) (Exelon 2006) and could be configured to fit within the existing, previously disturbed area of the Braidwood site. The staff concludes that land-use impacts associated with site-preparation, construction, and operation of a new nuclear unit at Braidwood would be SMALL.

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in determinating environmental preferability. Therefore, these impacts are discussed generically in Section 8.6.1.

There are two transmission lines, spanning a total of 134 km (84 mi) and covering 962 ha (2376 ac), that currently serve Braidwood (NRC 1996). Land cover along these lines consists of farmland (85 percent), open woodland and hedgerows (10 percent), and riparian woodlands (5 percent) (AEC 1974a).

The staff assumed that the existing transmission lines serving Braidwood do not have the capacity to carry the power that would be generated by a new unit at the site. It is likely that new transmission lines, and possibly additional rights-of-way, would be needed. The additional transmission lines could be installed via expansion of existing rights-of-way, which the staff considers to be the most likely scenario, or could follow a new right-of-way. Assuming that any transmission system modifications would be expansions of existing rights-of-way, for reasons similar to those discussed in Chapters 4 and 5 for expansion to support the ESP site, the staff concludes that the land-use impacts associated with right-of-way expansion would be SMALL. The procedures for adding new transmission lines to connect a new unit at Braidwood to the transmission grid are similar to those described in Section 3.3.

8.5.2.2 Hydrology, Water Use, and Water Quality

A new nuclear unit at Braidwood was assumed to withdraw makeup water from the Kankakee River. It would use cooling towers for station cooling. The staff estimated the 7Q10 (7-day average minimum annual flow) and 30Q2 (median 30-day minimum annual discharge) based on data from the USGS stream gauge 05527500 (Kankakee River near Wilmington, Illinois). Data for the period of record from 1914 through 2003 was used to estimate the 7Q10 and 30Q2 values. The drainage area upstream of the gauge is reported by the USGS to be 13,338 km^2 (5150 mi^2). The 7Q10 and 30Q2 values estimated by the staff are 13.1 m^3/s (463 cfs) and 21.7 m^3/s (765 cfs), respectively. The net consumptive loss for a wet cooling tower, based on the PPE, is 2.0 m^3/s (70 cfs) or 15 and 9.2 percent of the Kankakee River 7Q10 and 30Q2, respectively.

Any releases of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality was protected. Based on the requirements of the current Braidwood NPDES permit and the above analysis, the staff concludes that the water-use and water quality impacts of an additional unit at the Braidwood site would be SMALL.

8.5.2.3 Terrestrial Resources Including Endangered Species

Between the years 1940 and 1974, about 971 ha (2400 ac), about 54 percent of the 1804-ha (4457-ac) Braidwood site, was used for coal strip-mining (AEC 1974a). The majority of the remainder of the site consists of Braidwood Lake (IDNR 2003). The Braidwood site includes strip-mine spoils, cultivated fields, fallow fields, and open woodlands; no climax plant communities (tallgrass prairie with areas of deciduous forest) were found within its boundaries. Strip-mine spoils were interspersed with excavations containing stagnant water, and some marshy areas were found along roadsides and railroad tracks and between fields. Spoil areas were characterized as having packed, infertile soils with low vegetation density, and strip-mine spoils were reclaimed via revegetation programs that included planting woody and herbaceous species (AEC 1974a). Currently, partially to fully forested habitats occupy the area just west of the Braidwood site infrastructure whereas areas to the east appear to be mostly cleared of forest, based on 1998/1999 digital orthophoto quadrangle data (ISGS 2004).

There are two transmission corridors, which extend over 134 km (84 mi) (AEC 1974a) and cover 962 ha (2377 ac) (NRC 1996), that currently serve Braidwood Generating Station. Land cover along these lines consists of farmland (85 percent), open woodland and hedgerows (10 percent), and riparian woodlands (5 percent) (AEC 1974a). It is assumed that the two existing transmission lines do not have the capacity to carry the power that would be generated by a new unit at the Braidwood site, and it is likely that new transmission lines, and thus expanded rights-of-way, would be needed.

There are 24 State-listed threatened or endangered terrestrial species that occur within a 16-km (10-mi) radius of the Braidwood site, but only one of these, the endangered upland sandpiper (*Bartramia longicauda*), is known to occur within 3.2 km (2 mi) of the site (IDNR 2004c).

Construction Impacts

It is assumed that structures for a new nuclear unit (power block structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers) would be primarily constructed in areas already cleared of forest, if possible, and that forested habitat would thus be minimally impacted. Consequently, terrestrial ecological impacts from construction of a new unit at the Braidwood site would be negligible.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would be expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Based on this assumption, a loss of at least 48 ha (119 ac) of woodland could occur. Terrestrial ecological impacts associated with the upgrade would be expected to be negligible, because most of the land cover is agricultural and because loss of this amount of woodland over 134 km (84 mi) would be insignificant.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial resources from construction of a new nuclear unit at the Braidwood site and construction associated with possible upgrade of the existing Braidwood transmission system would be SMALL.

Operational Impacts

Impacts on terrestrial ecological resources from operation a new nuclear unit at the Braidwood site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There is one Federally listed threatened or endangered terrestrial species that may occur in the vicinity of the Braidwood site and transmission lines, the threatened eastern prairie fringed orchid (*Platanthera leucophaea*) (FWS 2004b). The eastern prairie fringed orchid is known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Braidwood site (IDNR 2004c). Its habitat includes, but is not restricted to, mesic prairie, sedge meadows, marsh edges, and bogs (FWS 2004b). It is unlikely that this species occurs on the Braidwood site, given the above description of habitats onsite, which appear to be unsuitable. There is no designated critical habitat for this species. Consequently, impacts to Federally listed species, from construction of a new nuclear unit on the Braidwood site and possible expansion of the transmission line rights-of-way would be minimal.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that impacts to threatened or endangered species from construction of a new nuclear unit at the Braidwood site and construction associated with possible upgrade of the existing Braidwood transmission system would be SMALL.

8.5.2.4 Aquatic Resources Including Endangered Species

Braidwood Lake was constructed in the late 1970s and impounded during 1980 and 1981 with water pumped from the Kankakee River. Several surface-mined pits were flooded within the lake, and fisheries management actually began in 1978 before the lake existed (IDNR 2003). The lake was a semi-private area used by employees of the power station until 1981 when the Department of Conservation (now the Illinois Department of Natural Resources) acquired a long-term lease agreement that allowed general public access. Braidwood Lake currently is used for recreational but not commercial fishing and is larger than any of the more than 200 water impoundments in the area which range from 0.3 to 12 ha (0.75 to 30 ac). The water area is managed by IDNR for sport fish and currently contains largemouth bass, smallmouth bass, bluegill, green sunfish, crappie, channel catfish, and bullhead (IDNR 2003). The area is also managed for other resident or migratory game and non-game fish species.

Construction Impacts

Water from the Kankakee River is used to cool the existing Braidwood station and would be expected to be used to cool a new nuclear unit constructed at that site. As the site was designed for four units, the space is already set aside for construction of an additional unit.

Although aquatic biota, including recreational sport fish, would be temporarily displaced during the construction period, they would be expected to recolonize the area after construction is complete. It is assumed that any disturbance to aquatic resources from construction would be localized and of relatively short duration. The NRC staff has reviewed information provided by Exelon and concludes that the environmental impacts of construction of a new nuclear unit at Braidwood on aquatic resources would be SMALL.

Operational Impacts

The aquatic impact most likely to occur as a result of operations of a new unit at Braidwood is entrainment and impingement of organisms from the Kankakee River (ComEd 1973; Exelon 2003a). Any new nuclear unit at the Braidwood ESP site would be required to meet the new EPA Phase I regulations, which is likely to require closed-cycle cooling. Operation of the new ESP unit utilizing closed-cycle cooling would withdraw substantially less water from the Kankakee River than the two existing Braidwood reactors, resulting in little additional impingement and entrainment loss. Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on aquatic resources during operation of a new nuclear unit at the Braidwood site would be SMALL.

Threatened or Endangered Species

No Federally protected aquatic species are found in the vicinity of the Braidwood site (Sackschewsky 2004). Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact to Federally listed threatened or endangered species from construction and operation of a new nuclear unit at the Braidwood site would be SMALL.

8.5.2.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new unit at the Braidwood site. The evaluation assesses impacts of construction and station operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of construction and operation of a new unit at Braidwood are similar to those of construction and operation of a new unit at the other alternative sites. They are discussed generically in Section 8.6.4.

Demography

The Town of Godley (population 594) is about 0.8 km (0.5 mi) from the site. Within a 8-km (5-mi) radius, there are the Towns of Coal City (population 4797) and Braidwood (population 5203) (USCB 2000c). Projected population of the area suggests that the population, including the transient population, within 16 km (10 mi) of the Braidwood Station will reach nearly 86,000 by the year 2020 (Exelon 2006). The population between 16 and 80 km (10 and 50 mi) includes the Chicago metroplex, and the total population is predicted to reach more than 5 million by the year 2020 (Exelon 2006). There are approximately 22 urban centers within a 48-km (30-mi) radius of the site (Exelon 2006).

As with Dresden, most construction and operation workers are expected to come from within the region. The total number of workers hired would be the same as with Dresden. Should some decide to relocate to Will County, the increase in population would be very small when compared to the total population already resident in the county.

As with Dresden, some new jobs might result from the multiplier effect attributable to the construction and operations workforce and might result in some increase in population in the region. However, when compared to the total population base in the region, these increases would be minimal. Any multiplier effects resulting from construction and operations workers' expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the demographic impacts of construction and station operation on increases in population within the region would be SMALL.

Impacts to the Community - *Social and Economic*

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the Braidwood site. Some of the impacts of construction and operation of a new nuclear unit that are generic are discussed in Section 8.6.4.

Economy

The economy surrounding Braidwood would be similar to Dresden's, which is described in Section 8.5.1.5. Will County would be the main beneficiary of construction and operation of a new nuclear unit at Braidwood. In Will County, the magnitude of the economic impacts would be diffused within the larger economic base, as is also the case in the surrounding counties. Thus, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and station operation on the economy of the region would be SMALL.

Taxes

All of Braidwood is in Will County. As a result, all of the property taxes paid by Exelon on the facility at Braidwood would go to Will County. The taxes, while large in absolute amount, would be small when compared to the total taxes collected by Illinois and Will County. In addition, Will County has a larger economic base than some of the surrounding counties. Thus, the percentage of total property taxes collected from Exelon for the Braidwood site would not be significant when compared to the total property taxes collected in the county. Therefore, the NRC staff concludes that the beneficial tax impacts (property, income, sales, and use taxes) of constructing and operating a new facility at Braidwood would be SMALL.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the Braidwood site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

Braidwood is located off Interstate (I) 55, which is less than 3.6 km (2 mi) west-northwest of the plant. Illinois State Routes (SRs) 53 and 129 are located less than 1.6 km (1 mi) to the northwest of the site. SR 113, located approximately 3.6 km (2 mi) north of the site, also provides access to the interstate and state highways.

There are currently 760 workers at Braidwood operating the two nuclear units. Construction of a new nuclear unit at Braidwood would employ 3150 workers, in addition to the 1000 or so employees already employed at Units 1 and 2. In addition, there would be approximately 1000 temporary workers employed during refueling outages. Refueling outages would most likely last approximately two weeks and refueling would most likely be on a 24-month staggered cycle for each unit.[a] Truck traffic would increase greatly and rail traffic would increase as well. Heavy loads of materials might necessitate additional maintenance on the roads leading to the site. While traffic counts on the roads around and leading to Braidwood were not available, congestion on the roads leading to and around the site could be expected, particularly at shift changes, which could be mitigated by staggering shifts so that all employees would not enter or

(a) More precise numbers for the Braidwood plant were not available. These estimates are based on the requirements at Dresden, a similar, sister facility to Braidwood (Exelon 2002a).

leave the site at the same times. Based on the information provided by Exelon and the NRC staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on transportation would be SMALL to MODERATE and some mitigating actions might need to be undertaken.

With respect to the operations workforce at the facility, adding approximately 580 cars, in addition to the cars of the temporary workers during refueling outages, (assuming a single occupant per car) to the existing 1000 cars on the road of employees of Braidwood Units 1 and 2 would not materially congest the highway except at shift changes. These impacts could be mitigated by staggering the shift changes between the two plants (Braidwood and a new nuclear unit) so that they would not all occur at the same time. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of the operations workforce on transportation would be SMALL, and that mitigation would not be warranted.

Aesthetics and Recreation

The terrain of the Braidwood site is relatively flat and open. The local terrain around the site is very flat and is largely rural and agricultural, characterized by farmland, woods, and small residential communities. Residential development exists to the northeast and south-southeast of the site. There are two boat-launching ramps on Braidwood's cooling reservoir that were in use at the time of the NRC staff visit (March 9, 2004).

The construction of a new nuclear unit at Braidwood could be viewed from offsite at certain locations, but the addition of another facility would not substantially change the view of the current Braidwood units. There might be a need to construct a cooling-water intake structure and discharge at the site. As the cooling reservoir is currently at maximum use with Braidwood Units 1 and 2, a new nuclear unit at the site would need one or more cooling towers. The operation of a new nuclear unit probably would have visual impacts similar to those of the existing Braidwood units, with the addition of occasional visible plumes from cooling towers. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation of a new nuclear unit on aesthetics would be SMALL and that further mitigation would not be warranted.

Housing

In Will County, there are 175,524 housing units, of which 7982 (5 percent) are vacant (USCB 2000b). A 5-percent vacancy rate would, on its surface, indicate a potential shortage of housing near the Braidwood site for the Exelon construction workforce of 3150. Assuming that the construction workforce would commute from an area within a 80-km (50-mi) radius of Braidwood, which has a population of several million, there would be few discernible impacts on housing availability, rental rates or housing values, or housing construction or conversion in Will County. Those who chose to relocate to the region would find adequate housing available. Therefore, based on information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on housing would be SMALL.

If built, a new nuclear unit at Braidwood would have up to 580 employees when it became operational (Exelon 2006). It is assumed, as with Dresden, that of the current employees at Braidwood, 72 percent live in Will and Grundy Counties. If it is assumed that the new operating workforce would not come from within the region, but would relocate to the region, and follow similar past practices, one would expect as many as 415 of the new operating employees to locate in the two counties. There are no growth restrictions in either Will or Grundy Counties. If the workers were not already in the region, Will County would have a sufficient number of housing units to handle the station operations personnel and their families. Should all of the 415 new employees locate to Will County, it is unlikely there would be discernible impacts on housing availability, rental rates, or housing values. There might be some new construction of housing, but it would be minor as a result of operating a new nuclear unit. Grundy County has a smaller housing base and vacant units. If all the new employees decided to relocate to Grundy County, there could be upward pressure on housing prices, on values, and on new construction.

It is expected that most of the operational workforce would already be in the region and have residences. Should this be the case, there would be little demand for housing. However, if the workers were not already in the region, Will County currently has a sufficient number of housing units to handle the station operations personnel and their families. Grundy County has a smaller housing base and less vacant units. If all the new employees decided to relocate to Grundy County, there could be upward pressure on housing prices. Therefore, based on the staff's independent review and on reconnaissance-level information, the staff concludes that the impacts of station operation on the availability of housing would be SMALL for Will County and MODERATE for Grundy County, and mitigation would occur through market forces, leading to the construction of new housing.

8.5.2.6 Historic and Cultural Resources

The impacts of construction and operation of a new nuclear unit on historic and cultural resources at the alternative sites are discussed generically in Section 8.6.5.

8.5.2.7 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations.

The staff used the Geographical, Environmental and Siting Information (GEn&SIS) database to develop maps of minority and low-income populations around the Braidwood site (GEn&SIS 2004). The data used are based on the 2000 Census and census blocks and followed the NRC criteria for determining the presence of low-income or minority populations (NRC 2004a; 69 FR 52040). Maps were created showing census blocks of minority and low-income populations within a 80-km (50-mi) radius of Braidwood. There is a concentration of minority populations located about 48 km (30 mi) to the southwest of Braidwood near Pontiac. Another concentration of minority populations lies 48 km (30 mi) to the southeast of the site, near Bourbonnais, Bradley, and Kankakee, and another concentration east of there along the Illinois-Indiana State line. To the northeast, the Chicago area has numerous concentrations of minority populations. For low-income populations, there is a concentration around Kankakee, another due east of Kankakee near and along the Indiana-Illinois State line, and within the Chicago metropolitan area.

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting these minority and low-income populations. Based on the staff’s independent review of reconnaissance-level information including a site visit to Braidwood (March 9, 2004), the staff concludes that environmental justice consequences of the construction and operation of a new nuclear unit at Braidwood would be SMALL and that mitigation would not be warranted.

8.5.3 LaSalle County Generating Station

The LaSalle County Generating Station is located on a site in the southeast corner of LaSalle County, Illinois. It is approximately 112 km (70 mi) southwest of the center of Chicago and approximately 39 km (24 mi) west-southwest of Dresden Nuclear Power Station. It is approximately 8 km (5 mi) south of the Illinois River, which at that point flows to the west. The land use around the site is predominately agricultural. Nearby towns around the site include Seneca (population 2053), Marseilles (population 4655), and Ransom (population 409) (USCB 2000d).

LaSalle occupies approximately 1238 ha (3060 ac) with two nuclear units in operation. The Illinois River is the primary surface-water source for the facility. LaSalle does not significantly affect surface-water use from the Illinois River because of an 833-ha (2058-ac) cooling pond. Exelon assumes that a cooling pond for a new nuclear facility would have roughly the same general environmental impact as that of the existing facility (Exelon 2006).

8.5.3.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

LaSalle County and the two counties adjacent to its southeast corner, Livingston and Grundy Counties, are predominantly agricultural areas. All three have a large percentage of their land under cultivation. Principal crops are corn, soybeans, and wheat; other crops include barley, rye, and hay. Livestock is another production commodity (AEC 1973). Land use remains predominantly agricultural. No new land will be preempted if new units are placed on the site.

Overall, the land-use factors of construction and operation of a new nuclear unit are not particularly site-dependent. The footprint of a new unit would be less than 41 ha (100 ac) (Exelon 2006) and could be configured to fit within previously disturbed land on the LaSalle site.

Based on these considerations, the staff concludes that the potential land-use impacts associated with site-preparation and construction and resulting from operation of a new unit at the LaSalle site would be SMALL.

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in determination of environmental preferability. Therefore, these impacts are discussed generically in Section 8.6.1.

There are 165 km (103 mi) of transmission lines covering 922 ha (2278 ac) that currently serve LaSalle (NRC 1996). Land cover along these lines consists primarily of farmland (NRC 1978).

The existing transmission lines for LaSalle do not have the capacity to carry the power that would be generated by a new nuclear unit. It is likely that new transmission lines, and possibly additional rights-of-way, would be needed. The additional transmission lines could be installed via expansion of an existing right-of-way, which the staff believes to be likely, or could follow a new right-of-way. Assuming that any additional transmission system modifications would be expansions of existing rights-of-way, for reasons similar to those discussed in Chapters 4 and 5 for expansion to support the Exelon ESP site, the staff concludes that the land-use impacts associated with the expansion would be SMALL. The procedures for adding the new transmission lines to connect a new nuclear unit at LaSalle to the transmission grid are similar to those described in Section 3.3.

8.5.3.2 Hydrology, Water Use, and Water Quality

A new nuclear unit at LaSalle was assumed by the staff to ultimately withdraw makeup water from the Illinois River. It is assumed that it will utilize wet cooling towers for station cooling. The staff estimated the 7Q10 (7-day average minimum annual flow) and 30Q2 (median 30-day minimum annual discharge) based on data from the USGS stream gauge 05543500 on the Illinois River near Marseilles, Illinois. Data for the period of record from 1919 through 2003 was used to estimate the 7Q10 and 30Q2 values. This gauge is slightly downstream of the alternative ESP site. The drainage area upstream of the gauge near the site is reported by the USGS to be 21,391 km^2 (8259 mi^2). The 7Q10 and 30Q2 values estimated by the staff are 85.7 m^3/s (3028 cfs) and 126 m^3/s (4451 cfs), respectively. The net consumptive loss for a wet cooling tower, based on the PPE, is 2.0 m^3/s (70 cfs), or 2.3 and 1.6 percent of the Illinois River 7Q10 and 30Q2, respectively.

Any releases of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality is protected. Based on the requirements of the current LaSalle NPDES permit and the above analysis, the staff concludes that the water use and water quality impacts of an additional unit at the LaSalle site would be SMALL.

8.5.3.3 Terrestrial Resources Including Endangered Species

The 1238-ha (3060-ac) LaSalle site supports five plant communities: upland woods, Illinois River floodplain woods, creek bottom woods, cleared woods on transmission line rights-of-way, and old fields in various stages of succession (NRC 1978). Partially to fully forested habitat is found north and northeast of the existing LaSalle site infrastructure, and areas cleared of forest are found to the west, south, and east, based on 1998/1999 digital orthophoto quadrangle data (ISGS 2004). The remainder of the site remains largely unaltered since the late 1970s.

There are 165 km (103 mi) of transmission lines (NRC 1978) covering 922 ha (2278 ac) (NRC 1996) that currently serve LaSalle. Land cover along these lines consists primarily of farmland (NRC 1978). It is assumed that these transmission lines do not have the capacity to carry the power that would be generated by a new nuclear unit at the LaSalle site, and it is likely that new transmission lines and, thus, expanded rights-of-way would be needed.

There is one State-listed threatened or endangered terrestrial species known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the LaSalle site, and none that occur within 3.2 km (2 mi) (IDNR 2004c).

Construction Impacts

The staff assumed that structures for a new nuclear unit (power block structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers) would be primarily constructed in areas already cleared of forest, if possible, and that forest habitat would thus be minimally impacted. Consequently, terrestrial ecological impacts from construction of a new nuclear unit on the LaSalle site would be negligible.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would be expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Terrestrial ecological impacts associated with the upgrade would be expected to be negligible because most of the land cover is agricultural.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial resources from construction of a new nuclear unit at the LaSalle site and construction associated with possible upgrade of the existing LaSalle transmission system would be SMALL.

Operational Impacts

Impacts on terrestrial ecological resources from operation of a new nuclear unit at the LaSalle site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There are two Federally listed threatened or endangered terrestrial species that may occur in the vicinity of the LaSalle site and transmission lines: the threatened bald eagle (*Haliaeetus leucocephalus*) and the endangered Indiana bat (*Myotis sodalis*) (FWS 2004a). The bald eagle is known to winter along large rivers, lakes, and reservoirs in LaSalle County; however, no night roost sites are known to occur there. The Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004a). However, there is no suitable habitat for the Indiana bat near LaSalle and the species does not occur on or near the site (NRC 1978). Designated critical habitat exists for only one of these two Federally listed species, the Indiana bat (FWS 2004a). The only critical habitat in Illinois is the Blackball Mine (FWS 1976), located near Utica in LaSalle County, about 32 km (20 mi) northwest of the LaSalle site (NRC 1978). Consequently, impacts to Federally listed species from construction of a new nuclear unit on the LaSalle site and possible expansion of the transmission line rights-of-way would be minimal.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on threatened or endangered species from construction of a new nuclear unit at the LaSalle site and construction associated with a possible upgrade of the existing LaSalle transmission system would be SMALL.

8.5.3.4 Aquatic Resources Including Endangered Species

LaSalle is approximately 6.6 km (4 mi) south of the Illinois River in southeast LaSalle County. The Illinois River near the plant has been reported to have essentially no commercial or recreational value for fishing because of reduced biological diversity related to pollutants (AEC 1973). LaSalle Lake is an 833-ha (2058-ac) reservoir that serves as a cooling reservoir for LaSalle. Soil excavated for the lake's construction was used to build the shoreline and internal dikes, which are covered with rock riprap. The raised dikes are used to direct cooling water through a 5-day circulation pattern from the discharge channel back to the intake channel. There is typically an 11°C (20°F) water-temperature difference between the two channels. The average depth of LaSalle Lake is 4.6 m (15 ft), but there are excavated areas within the lake up to 21.3 m (70 ft) deep (IDNR 2004b). The lake is popular with anglers who may encounter walleye, muskellunge, tiger muskie, yellow bass, white bass, striped bass, hybrid striped bass, largemouth and smallmouth bass, white crappie, black crappie, bluegill, bullhead and channel catfish, freshwater drum, carp, goldfish, minnows, suckers, and threadfin shad (LaSalle Cooling Lake 2004). Largemouth and smallmouth bass, channel catfish, walleye, sauger, crappie, and hybrid striped bass have all been stocked since 1989 (Madeja 2002).

Construction Impacts

While aquatic biota, including recreational sport fish, would be temporarily displaced during the construction period, they would be expected to recolonize the region after construction was complete. It is expected that the disturbance to aquatic resources would be localized and of relatively short duration. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the environmental impacts of construction of a new nuclear unit on aquatic resources would be SMALL.

Operational Impacts

LaSalle does not significantly affect surface-water use from the Illinois River because of the 833-ha (2058-ac) cooling reservoir. However, according to plant personnel (interviewed during a site visit on March 11, 2004, by NRC staff), the reservoir is near its cooling capacity in serving the two existing nuclear units at the site.

Even if water for a new nuclear unit was withdrawn from the Illinois River, adverse impacts to aquatic environments as a result of impingement and entrainment are not expected to result. The Illinois River is best characterized as a recovering river system, and abundance and diversity of aquatic species and habitats are restricted by upstream pollutants, commercial and recreational boat traffic, and continuing habitat alteration. These factors arise from offsite use of the river corridor; operation of the current LaSalle nuclear facility is not a significant factor in the overall quality of aquatic habitats in the vicinity of the plant (Exelon 2006). In addition, any new nuclear unit at the LaSalle ESP site would be required to meet the new EPA Phase I regulations, which is likely to require closed-cycle cooling. Operation of a new ESP unit utilizing closed-cycle cooling would withdraw little water from the Illinois River, resulting in little additional entrainment or impingement loss.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the potential for adverse impacts to aquatic resources from operation of a new nuclear unit at LaSalle would be SMALL.

Threatened or Endangered Species

No Federally protected aquatic species are found in the vicinity of the LaSalle site (Sackschewsky 2004). Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact to Federally listed threatened or endangered species from construction and operation of a new nuclear unit at the LaSalle site would be SMALL.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the potential for adverse impacts to aquatic resources, including Federally listed threatened or endangered species, from operation of a new nuclear unit at LaSalle. The impact would be SMALL.

8.5.3.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new nuclear unit at the LaSalle site. The evaluation assesses impacts of construction and station operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of the construction and operation of a new nuclear unit at LaSalle are similar to those for the other alternative sites. They are discussed generically in Section 8.6.4.

Demography

LaSalle is located in the southeast corner of LaSalle County, Illinois (population 115,509) (USCB 2000d). It is approximately 110 km (70 mi) southwest of the center of Chicago and approximately 39 km (24 mi) west-southwest of the Dresden Nuclear Power Station. It is approximately 8 km (5 mi) south of the Illinois River, which at that point flows to the west. The land use around the site is predominantly agricultural. Nearby towns around the site include Seneca (population 2053), Marseilles (population 4655), and Ransom (population 409) (USCB 2000d).

Most construction and operation workers are expected to come from within the region. The total number of workers hired would be about 3150. Should some decide to relocate to LaSalle County, the increase in population would be very small when compared to the total population already resident in the county.

Some new jobs might result from the multiplier effect attributable to the construction and operations workforce and might result in some increase in population in the region. But these increases, when compared to the total population base in the region, would be minimal. Any multiplier effects resulting from construction and operations workers' expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity.

Based on the information provided by Exelon and the NRC staff's independent review of reconnaissance-level information, the staff concludes that the demographic impacts of construction and station operations within the region would be SMALL.

Impacts to the Community - Social and Economic

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the LaSalle site. Some of the impacts of construction and operation of a new nuclear unit that are generic are discussed in Section 8.6.4.

Economy

LaSalle County and the two counties adjacent to its southeast corner, Livingston and Grundy Counties, have a large agricultural base. All three counties have a large percentage of their land in cultivation. Crops grown include corn, soybeans, wheat, barley, rye, and hay; livestock are also raised.

LaSalle County's business profile is led by retail trade, which has 18 percent of the County's total employment, followed by manufacturing (17 percent) and health care and social assistance (13 percent) (USCB 2001c). The unemployment rate for LaSalle County in 2000 was 5.3 percent, while that for Illinois as a whole was 4.3 percent (IDES 2000a, 2000b).

In counties other than LaSalle County, which will not experience the direct benefits of construction or operation, the magnitude of the economic impacts would be diffused within the larger economic base. In LaSalle County, Exelon contributes moderately to the tax base (see discussion under "Taxes" below). By inference, the same would be expected in the other economic contributions to the county's economy. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and station operation on the economy of the region would be SMALL in all counties in the region except LaSalle County, where it could be MODERATE. In all cases, the impacts would be beneficial.

Taxes

Taxes collected as a result of constructing and operating a new nuclear unit at LaSalle would be of benefit to the State and to local jurisdictions that collect and spend them. Exelon would pay annual property taxes to LaSalle County. For the tax year 2003 to 2004, Exelon paid approximately 15 to 18 percent of the total property taxes paid in LaSalle County for the existing LaSalle nuclear facility.[a]

Personal and corporate income taxes and sales and use taxes would also be collected during the construction and operating periods of a new nuclear unit. While large in absolute amount, these tax amounts would be small when compared to the total taxes collected by Illinois as a whole and by LaSalle County. Based on the staff's independent review of reconnaissance-level information, the staff concludes that for LaSalle County the beneficial impacts of taxes collected during construction would be beneficially SMALL, that the beneficial impacts of taxes collected during operation would be beneficially SMALL to MODERATE,[b] and that further mitigation would not be warranted.

(a) Personal telephone communication with Gary Kleinhans, Chief Deputy to the LaSalle County Treasurer, May 28, 2004.

(b) The MODERATE impact is based on the impact of deregulation (see Section 2.8.2.2). While a new nuclear unit would potentially operate in a deregulated environment, the impacts of deregulation on the facility's value, and thus property taxes paid by the facility, are not fully known. Given the facility's potential value and property taxes paid to LaSalle County, the staff assumed that the facility's impact on collected property taxes would, at a minimum, be SMALL and could be MODERATE when compared to the taxes the facility could pay and the total property taxes collected by the county.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the LaSalle site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

The major transportation routes near the site include the Illinois River, approximately 5 km (3 mi) north of the northern boundary; Illinois State Highway 170, 0.8 km (0.5 mi) east of the eastern boundary of the site; and I-80, 13 km (8 mi) north of the northern site boundary. The Chicago, Rock Island, & Pacific Railroad, approximately 5 km (3 mi) north of the northern site boundary, is the closest operable railroad line (Exelon 2006).

The construction workforce would number 3150 (Exelon 2006), in addition to what are believed to be about 1000-plus operating employees of LaSalle Units 1 and 2. There are approximately 760 temporary workers employed over a two-week period during refueling outages. Refueling is on an approximate 24-month staggered cycle for each unit.[a] If the construction of a new nuclear unit were to follow past practices when Units 1 and 2 were constructed, construction would attract a large number of workers who would commute to the site from the surrounding area (AEC 1973). Highway transport would be used in the conveyance of construction materials to the site. Both of these events would put more traffic on the roads leading to the site, resulting in more congestion, particularly at shift changes. Corrective measures probably could be taken to minimize traffic congestion and safety hazards, such as using multi-shift workforces.

The NRC staff observed highway traffic around LaSalle during its site visit. The addition of upwards of 3150 cars, in addition to the approximately 760 cars of the temporary workers during refueling outages, (assuming a single occupant per car) on the road leading to the site could cause congestion, particularly at shift changes, and could be exacerbated with the addition of trucks carrying construction materials to the site. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on transportation would likely be SMALL, provided that impacts are actively mitigated, to MODERATE, if mitigation does not take place.

During operation of a new nuclear unit, adding approximately 580 cars, in addition to the approximately 760 cars of the temporary workers during refueling outages, (assuming a single

(a) More precise numbers for the LaSalle plant were not available. These estimates are based on the requirements at Dresden, a similar, sister facility to LaSalle (Exelon 2002a).

occupant per car), to what are believed to be about 1000 cars for operating employees of LaSalle Units 1 and 2, would not materially congest the highway except at shift changes. These impacts could be mitigated by staggering the shift changes among the plants (the current units and the new unit). Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of a new nuclear unit on transportation would be SMALL, and that mitigation is not warranted.

Aesthetics and Recreation

The Rock River is the major waterway for the area surrounding the LaSalle site. The Illinois River is the primary surface-water source for the facility and an important source of commercial and recreational navigation. The topography of the site is flat, with open grassland and few woods, except in the corridor that contains the pipelines for intake and discharge of cooling water to the Illinois River. LaSalle has a cooling reservoir, which is open for recreation.

Construction of a new nuclear unit would not be expected to have major impacts on the Illinois River due to the distance of the site from the river. Any impacts to the river of an additional cooling-water structure, if needed, would be transitory. Based on the staff's independent review of reconnaissance-level information, the staff concludes that the impacts on aesthetics and recreation of construction of a new nuclear unit at LaSalle would be SMALL and that mitigation would not be warranted.

The main visual impacts of operating a new nuclear unit would be the addition of a cooling tower onsite. None currently exists, but the cooling reservoir is near its capacity because of the heat load of LaSalle Units 1 and 2. In some meteorological conditions, the plume from a cooling tower could be seen for miles. This would add marginally to the visual impacts. However, recreation on the cooling reservoir likely would not be materially impacted. Based on the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation of a new nuclear unit at LaSalle would be SMALL, and that mitigation is not warranted.

Housing

In the six-county area of LaSalle, Bureau, Grundy, Kendall, DeKalb, and Lee Counties in 2000, there were a total 143,626 housing units, of which 8009 units were vacant (6 percent of the total [USCB 2000d]). Most construction workers would come from within the region and commute to the job site. Most of the workers hired for the initial construction of LCGS came from neighboring communities, such as Streator, Ottawa, Joliet, and Kankakee (NRC 1978). Thus, with the construction of a new nuclear unit, relatively few workers would be expected to move and take up residence in the area, and those that did could find housing within the six-county area.

When operational, a new nuclear unit would have up to 580 employees (Exelon 2006). Information on where the current 1000-plus operating employees of LaSalle Units 1 and 2 live was not available, although Commonwealth Edison estimated that less than 20 percent of the total operating staff for LaSalle Units 1 and 2 relocated to the local area, defined as Ottawa, Streator, and Marseilles (NRC 1978). There are 3021 vacant housing units in LaSalle County, a 6.5-percent vacancy rate (USCB 2000d). If 115 (20 percent of the 580 new operations employees) employees decided to live in LaSalle County, there would not be a discernable impact on housing availability, rental rates, or housing values. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of station construction and operation on the availability of housing would be SMALL and that mitigation would not be warranted.

8.5.3.6 Historic and Cultural Resources

The impacts of construction and operation of a new nuclear unit at the LaSalle site on historic and cultural resources are discussed generically in Section 8.6.5.

8.5.3.7 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations.

The staff used the GEn&SIS database to develop maps of minority and low-income populations around the LaSalle site (GEn&SIS 2004). The data used are based on the 2000 Census and census blocks and followed the NRC criteria for determining the presence of minority or low-income populations (NRC 2004a; 69 FR 52040). Maps were created showing census blocks of minority and low-income populations within 80 km (50 mi) of the LaSalle site.

There is a concentration of minority populations about 48 km (30 mi) south of LaSalle, near Pontiac. Another concentration of minority populations lies 48 km (30 mi) to the southeast of the site, near the Towns of Bourbonnais, Bradley, and Kankakee, and another small concentration east of there along the Illinois-Indiana State line, 64 km (40 mi) from the site. The Chicago area to the northeast has large concentrations of minority populations. Low-income populations are concentrated around Kankakee, another due east of Kankakee near and along the Indiana-Illinois State line, and within the Chicago metropolitan area.

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting these minority and low-income populations. Based on the staff's independent review of reconnaissance-level information including a site visit to LaSalle on March 11, 2004, the staff concludes that the environmental justice consequences of the construction and operation of a new nuclear facility would be SMALL and that mitigation would not be warranted.

8.5.4 Quad Cities Generating Station

The Quad Cities Generating Station is located in Rock Island County, Illinois, on the east bank of Pool 14 of the Mississippi River, about 26 km (16 mi) below Dam 13 and 21 km (13 mi) from Dam 14. The station is approximately 800 km (500 mi) upstream from the Mississippi's confluence with the Ohio River (i.e., River Mile 506.5) (Exelon 2002b).

The Quad Cities metropolitan area, consisting of the cities of Davenport and Bettendorf, Iowa, and Rock Island, Moline, and East Moline, Illinois, is located 32 km (20 mi) southwest of the Quad Cities site. The station is about 6 km (4 mi) north of Cordova, Illinois, and 16 km (10 mi) southwest of Clinton, Iowa (Exelon 2002b). The region within 10 km (6 mi) of the site includes portions of Rock Island and Whiteside Counties in Illinois and Scott and Clinton Counties in Iowa.

The Quad Cities site consists of 331 ha (817 ac) and includes two nuclear reactors and their turbine buildings, intake and discharge canals, and ancillary buildings, switchyards, and a retired spray canal now used to raise fish (NRC 2004c). Most of the western portion of the Quad Cities site is industrial, containing the major generating facilities, switchyard, warehouses, parking lots, and roads. Open fields and areas of planted pines occupy most of the eastern portion of the Quad Cities site. With the exception of an industrial park immediately north of the site and some forested bottom lands between the developed portion of the site and the Mississippi River, the surrounding lands are mostly agricultural, with large fields planted in grain (primarily corn) and forage crops. The station uses a once-through cooling system with the Mississippi River as source and receiving waters.

8.5.4.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Land around the station supports a combination of agricultural and industrial uses. Some land in the region has been set aside for recreational and environmental use. The Mississippi River supports a large sport fishery as well as commercial and recreational boating. Current land use at the Quad Cities site is not expected to change or expand, and there would be no preemption or adverse effects on land that has been set aside for environmental or recreational uses (Exelon 2006).

In its ER, Exelon states that the site does not have additional available land within its boundaries to build a new nuclear unit. An operating unit would need to be decommissioned and dismantled so that the new nuclear unit could be constructed on the decommissioned unit's footprint (Exelon 2006).

Overall, the land-use factors of construction and operation of a new nuclear unit are not particularly site-dependent. The staff visited the Quad Cities site in March 2004. The footprint of a new unit would be less than 41 ha (100 ac) (Exelon 2006) and, based on observation of the site, the staff believes it could be configured to fit within the existing, previously disturbed 331 ha (817 ac) of the Quad Cities site. Based on these considerations, the staff concludes that the potential land-use impacts associated with site-preparation and construction and resulting from operation of a new unit at the Quad Cities site would be SMALL.

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in the determination of environmental preferability. Therefore, these impacts are discussed generically in Section 8.6.1.

Five transmission lines connect Quad Cities Units 1 and 2 to the electric grid. These lines span 184 km (115 mi) and cover approximately 890 ha (2200 ac), traversing 90 to 95 percent agricultural land along with some natural terrestrial habitats, the upper Mississippi River National Wildlife and Fish Refuge (NWFR), and the Princeton Wildlife Management Area (NRC 2004c).

The existing transmission lines serving the Quad Cities site are assumed not to have the capacity to carry the power that would be generated by a new nuclear unit. It is likely that new transmission lines and possibly additional rights-of-way would be needed. An additional transmission line could be installed via an expansion of an existing right-of-way, which the staff believes to be the likely scenario, or could follow a new right-of-way. Assuming that any transmission system modifications would be expansions of existing rights-of-way for reasons similar to those discussed in Chapters 4 and 5 for expansion to support the Exelon ESP site, the staff concludes that the land impacts associated with the expansion would be SMALL. The procedures for adding the new transmission lines to connect a new nuclear unit at Quad Cities to the transmission grid are similar to those described in Section 3.3.

8.5.4.2 Hydrology, Water Use, and Water Quality

The staff assumed that a new nuclear unit at the Quad Cities site would use cooling towers for station cooling and withdraw makeup water from the Mississippi River. Because there is no stream gauge on the Mississippi River near the Quad Cities location, the staff estimated the 7Q10 (7-day average minimum annual flow) and 30Q2 (median 30-day minimum annual discharge) based on data from three USGS stream gauges: 05420500 (Mississippi River at Clinton, Iowa), 05422000 (Wapsipinicon River near DeWitt, Iowa), and 05446500 (Rock River near Joslin, Illinois). Data for the period of record from 1939 through 2003 were used to estimate the 7Q10 and 30Q2 values. The drainage area contributing to the site was estimated to be 253,819 km^2 (98,000 mi^2). The 7Q10 and 30Q2 values estimated by the staff are 439 m^3/s (15,490 cfs) and 723 m^3/s (25,532 cfs), respectively. The net consumptive loss for a wet cooling tower, based on the PPE, is 2.0 m^3/s (70 cfs) or 0.5 and 0.3 percent of the Mississippi River 7Q10 and 30Q2, respectively.

Any releases of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality is protected.

Based on the requirements of the current Quad Cities NPDES permit and the above analysis, the staff concludes that the water-use and water quality impacts of an additional unit at the Quad Cities site would be SMALL.

8.5.4.3 Terrestrial Resources Including Endangered Species

The 331-ha (818-ac) Quad Cities site is located in an area with sandy soil and little shrub or forest habitat. The site consists of developed and undeveloped areas. The developed areas mostly occupy the western half of the site. Undeveloped areas are located generally on the eastern half of the site and support habitats that include open fields and planted pines (NRC 2004c).

Five transmission lines connect Quad Cities Units 1 and 2 to the electric grid. These lines are 185 km (116 mi) long and traverse 90 to 95 percent agricultural land, along with some natural terrestrial habitats, the Upper Mississippi River National Wildlife and Fish Refuge (NWFR) and Princeton Wildlife Management Area (NRC 2004c). They cover approximately 880 ha (2200 ac). It is assumed that these transmission lines do not have the capacity to carry the power that would be generated by a new unit at the Quad Cities site, and it is likely that new transmission lines and, thus, expanded rights-of-way would be needed.

There are four State-listed threatened or endangered terrestrial species known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Quad Cities site, and one (the river otter [*Lutra canadensis*]) that occurs within 3.2 km (2 mi) (IDNR 2004c).

Construction Impacts

The staff assumed that structures for a new nuclear unit (power block structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers) would be constructed primarily in developed areas of the Quad Cites site, where possible. However, if construction were to occur in undeveloped portions of the site, it would also of be of minor ecological consequence because of the disturbed nature of the habitats that occur there (e.g., open fields and planted pines). Consequently, terrestrial ecological impacts from construction of a new nuclear unit at the Quad Cities site would be negligible.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would be expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Terrestrial ecological impacts associated with the upgrade could range from minor to extensive, depending on potential impacts to the Upper Mississippi River NWFR and Princeton Wildlife Management Area.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial resources from construction of a new nuclear unit at the Quad Cities site and construction associated with possible upgrade of the existing Quad Cities transmission system could range from SMALL to LARGE.

Operational Impacts

Impacts on terrestrial ecological resources from operation of a new nuclear unit at the Quad Cities site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alterative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There are six Federally listed threatened or endangered terrestrial species that may occur in the vicinity of the Quad Cities site and its transmission lines: Indiana bat (*Myotis sodalis*), bald eagle (*Haliaeetus leucocephalus*), Iowa Pleistocene snail (*Discus macclintocki*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), and prairie bush clover (*Lespedeza leptstachya*) (NRC 2004c; FWS 2004a). Of these six species, designated critical habitat exists only for the Indiana bat (FWS 1976, 2004a; NRC 2004c).

The endangered Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004a). However, its occurrence on the Quad Cities site has not been noted (NRC 2004c). The only critical habitat for the Indiana bat in Illinois is the Blackball Mine in LaSalle County (FWS 1976).

The threatened bald eagle is known to winter and night roost along large rivers, lakes, and reservoirs in Rock Island County (FWS 2004a). The bald eagle is a common visitor to the Upper Mississippi River Valley (within which the Savanna District of the Upper Mississippi River

NWFR is located), to which the Quad Cities site is adjacent. The bald eagle uses this area as a winter migration corridor and for nesting. The bald eagle nest nearest to the Quad Cities site is located on Beaver Island, 11 km (7 mi) to the north (NRC 2004c; IDNR 2004c).

The endangered Iowa Pleistocene snail inhabits algific (i.e., cold-producing) talus slopes, within the leaf litter of cool and moist hillsides. The snail has been found at approximately 30 sites in Iowa and Illinois, but not at the Quad Cities site. Suitable habitat is unlikely to occur at the site because the majority of the land is flat and agricultural (NRC 2004c).

The threatened western prairie fringed orchid occurs in mesic to wet tallgrass prairies and meadows, but is also found in old fields and roadside ditches. It is restricted to areas west of the Mississippi River and is thus unlikely to be found at the Quad Cities site (NRC 2004c).

The threatened eastern prairie fringed orchid prefers mesic to wet tallgrass prairie or grassland habitats, but can also occupy bogs, fens, and sedge meadows. No occurrences of this species have been documented on the Quad Cities site (NRC 2004c).

The threatened prairie bush clover occurs on dry gravel and sand prairies, in areas too rocky or steep to be plowed. Fourteen known populations occur in Illinois at present, but none of these is in Rock Island County (NRC 2004c).

Occurrences of the Indiana bat, Iowa Pleistocene snail, western and eastern prairie fringed orchids, and prairie bush clover on the Quad Cities site are unlikely. The bald eagle nest nearest to the Quad Cities site is sufficiently distant to preclude disturbance. Consequently, potential impacts to these species from construction of a new nuclear unit on the Quad Cities site would be minimal.

The six Federally listed species noted above could occur in areas along the Quad Cities transmission lines. However, occurrence of the Indiana bat along the Quad Cities transmission lines has not been noted (NRC 2004c). The bald eagle nest nearest to a Quad Cities transmission line is located on Beaver Island, 7.2 km (4.5 mi) north of the Rock Creek transmission line (NRC 2004c). Suitable habitat for the Iowa Pleistocene snail is unlikely to occur in the immediate vicinity of the Quad Cities transmission line rights-of-way because the majority of this land is flat and agricultural (NRC 2004c). The western prairie fringed orchid could be found along the Davenport and Rock Creek transmission lines but has not been documented there (NRC 2004c). The eastern prairie fringed orchid could be found along the Quad Cities transmission lines but has not been documented there (NRC 2004c). It is unlikely that the prairie bush clover would be along the Quad Cities transmission lines because it grows primarily on agricultural land.

Occurrences of the Indiana bat, Iowa Pleistocene snail, western and eastern prairie fringed orchids, and prairie bush clover along the Quad Cities transmission lines are unlikely. The bald eagle nest nearest to the Quad Cities transmission lines is sufficiently distant to preclude disturbance. Consequently, potential impacts to these species from possible expansion of the transmission line rights-of-way would be minimal.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on threatened and endangered species from construction of a new nuclear unit at the Quad Cities site and construction associated with possible upgrade of the existing Quad Cities transmission system would be SMALL.

8.5.4.4 Aquatic Resources Including Endangered Species

The principal aquatic resources in the vicinity of the Quad Cities site are associated with the Mississippi River. Other important aquatic habitats include several tributaries of the Mississippi River (e.g., the Wapsipinicon River in Iowa that flows into the Mississippi River immediately upstream of the Quad Cities site) and the Quad Cities Units 1 and 2 retired spray canal. The spray canal is currently used to raise walleye (*Sander vitreus*) primarily for release into Pool 14 of the Mississippi River (NRC 2004c).

The overall fish biodiversity of the Upper Mississippi River has been persistent and resilient. Fish species considered abundant within the Upper Mississippi River include gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*), river shiner (*N. blennius*), bullhead minnow (*Pimephales vigilax*), and bluegill (*Lepomis macrochirus*). Common species include longnose and shortnose gar (*Lepisosteus osseus* and *L. platostomus*), bowfin (*Amia calva*), mooneye (*Hiodon tergisus*), spottail shiner (*N. hudsonius*), river carpsucker (*Carpiodes carpio*), quillback (*C. cyprinus*), bigmouth buffalo (*Ictiobus cyprinellus*), shorthead redhorse (*Moxostoma macrolepidotum*), channel catfish (*Ictalurus punctatus*), white and hybrid white bass (*Morone chrysops* and *M. chrysops* x *M. saxatilis*), rock bass (*Ambloplites rupestris*), green sunfish (*Lepomis cyanellus*), and river darter (*Percina shumardi*) (NRC 2004c). Favorite sport fish species include walleye, sauger (*Sander canadensis*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), white bass (*Morone chrysops*), bluegill, black and white crappie (*Pomoxis nigromaculatus* and *P. annularis*), pumpkinseed (*L. gibbosus*), and channel catfish (*Ictalurus punctatus*). Commercial fisheries also exist for some species, such as the bigmouth buffalo, common carp, catfish and bullheads (Ictaluridae), and freshwater drum (*Aplodinotus grunniens*) (NRC 2004c).

The impoundments for the navigation system on the Mississippi River favor submersed aquatic vegetation by increasing shallow water surface area and stabilizing low-discharge water levels (NRC 2004c). Generally, benthic macroinvertebrate densities are low throughout the Upper Mississippi. The Upper Mississippi River contains a rich assemblage of freshwater mussels. The non-indigenous zebra mussel (*Dreissena polymorpha*) became established in the Upper

Mississippi River by 1992 and has continued to spread throughout the river system. Its increase causes a decline in many native mussels, as it can out-compete native species for oxygen and food and is so prolific that it can smother native mussel beds.

Construction Impacts

The construction of a cooling-water intake structure and discharge might be necessary if a new nuclear unit were to be located at the Quad Cities site. Aquatic biota, including recreational sport fish, would be temporarily displaced during the construction period. However, they would be expected to recolonize the region after construction is complete. It is expected that the disturbances to aquatic resources would be localized and of relatively short duration.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the potential impacts of construction of a new nuclear unit at the Quad Cities site on aquatic resources would be SMALL.

Operational Impacts

The aquatic impact most likely to occur as a result of operations of a new nuclear unit at the Quad Cities site would be impingement and entrainment of organisms from the Mississippi River. Any new nuclear unit at the Quad Cities ESP site would be required to meet the new EPA Phase I ruling, which is likely to require close-cycle cooling. Operation of the new ESP unit utilizing closed-cycle cooling would withdraw substantially less water from the Mississippi River than the two Quad Cities reactors, resulting in significantly less impingement and entrainment loss. Therefore, the potential for adverse impacts to aquatic resources from operation of a new nuclear unit at Quad Cities would be SMALL.

Threatened or Endangered Species

One endangered aquatic species listed by the U.S. Fish and Wildlife Service, the Higgins' eye pearlymussel (*Lampsilis higginsii*), has the potential to occur in the vicinity of Quad Cities (NRC 2004c). Two areas designated as Essential Habitat Areas are located as near as 1.6 km (1 mi) downstream of the Quad Cities site (NRC 2004c; FWS 2003). These Essential Habitat Areas are locations known to contain reproducing populations of the Higgins' eye pearlymussel in association with a healthy and diverse community (e.g., mussel beds). This species is found in sand/gravel substrates and swift-flowing currents.

Prior to any in-river activities during construction, a survey of the river bottom could be conducted to determine if the Higgins' eye pearlymussel is present in the area of impact. If present, individual mussels could be relocated from the site, either temporarily or permanently, in advance of in-water construction activities.

Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact on Federally listed threatened or endangered aquatic species from construction and operation of a new nuclear unit at the Quad Cities site would be SMALL if mitigation measures are followed, but could be MODERATE if measures are not followed to protect the endangered Higgins' eye pearlymussel.

8.5.4.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new nuclear unit at the Quad Cities site. The evaluation assesses impacts of construction and operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of the construction and operation of a new nuclear unit at Quad Cities are similar to those for the other alternative sites. They are discussed generically in Section 8.6.4.

Demography

The Quad Cities site is located in Rock Island County, Illinois, on the east bank of the Mississippi River, 6.4 km (4 mi) north of Cordova, Illinois, and 16 km (10 mi) southwest of Clinton, Iowa (Exelon 2002b). The site is approximately 800 km (500 mi) upstream from the Mississippi's confluence with the Ohio River (Exelon 2002b) and approximately 264 km (165 mi) west of Chicago. The Quad Cities metropolitan area, consisting of the Cities of Davenport and Bettendorf, Iowa, and Rock Island, Moline, and East Moline, Illinois, is located 20 miles southwest of Quad Cities. The region within 6 miles of the site includes portions of Rock Island and Whiteside Counties in Illinois and Scott and Clinton Counties in Iowa (Exelon 2002b). Rock Island County is a part of the Davenport-Moline-Rock Island, Iowa-Illinois Metropolitan Statistical Area (MSA) which also includes East Moline, Illinois and Bettendorf, Iowa. The 2000 Census population of the Metropolitan Statistical Area was 359,062 (USCB 2000e).

Some new jobs might result from the multiplier effect attributable to the construction and operations workforce and might result in some increase in population in the region. But these increases, when compared to the total population base in the region, would be minimal. Any multiplier effects resulting from construction and operation workers' expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity. Most of the construction and operation workers would be expected to come from within the region. Even if all the construction and operation workforce were to relocate to the region, they would represent a small percentage increase in the total population base. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on increases in population within the region would be SMALL.

Impacts to the Community - Social and Economic

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the Quad Cities site. Some of the impacts of construction and operation of a new unit that are generic are discussed in Section 8.6.4.

Economy

The recession of the early 1980s affected the agricultural sector and the smokestack industries that relied upon the farm business. During that recession, the region's workforce declined by 1.1 percent (Exelon 2002b). The area is still recovering; however, a shift has taken place from an economy that was heavily reliant on agriculture to one centered on service providers (Exelon 2002b).

The nonprofessional services sector realized a 121.1 percent increase in employment between 1980 and 1996. During that same period, manufacturing employment declined by 41 percent, durable goods production by 54.4 percent, and non-electrical machine production by 63.3 percent (Exelon 2002b). For Rock Island County, the 2001 leading economic employment sectors and respective rankings were as follows: manufacturing (14 percent), retail trade (12 percent), and health care and social assistance (13 percent) (USCB 2001g). For Scott County, Iowa, the leading sectors were manufacturing (16 percent), retail trade (14 percent), and healthcare and social assistance (12 percent) (USCB 2001h). For Whiteside County, Illinois, the 2001 leading sectors were manufacturing (30 percent), healthcare and social assistance (17 percent), and retail trade (16 percent) (USCB 2001i).

The annualized unemployment rate for the State of Illinois for 2000 was 4.3 percent. In comparison, Rock Island and Whiteside Counties had 2000 unemployment rates of 4.6 and 4.2 percent, respectively (IDES 2000a). For the State of Iowa, the annualized unemployment rate for 2000 was 2.7 percent. Scott County's 2000 unemployment rate was 3.3 percent (not seasonally adjusted) (IWD 2000a, 2000b).

In summary, the magnitude of the economic impacts would be diffused within the larger economic base of the Quad Cities region. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and operation on the economy of the region would be SMALL.

Taxes

Taxes collected as a result of constructing and operating a new nuclear unit at the Quad Cities site would be of benefit to the State and to local jurisdictions that collected and spend them. The Quad Cities site would pay property taxes to Rock Island and other jurisdictions within the County. For the years 1997 to 2000, the Quad Cities property taxes provided approximately 2.8 percent of Rock Island County's total collections available for distribution (Exelon 2002b). Personal and corporate income taxes and sales and use taxes would also be collected over the construction and operating periods for a new facility. While large in absolute amount, the amounts collected would be small when compared to the total taxes collected by Illinois and Rock Island County. Similarly, while the total sales, use, and income taxes would be large in absolute amounts, they would be small when compared to the total taxes collected. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and operation on taxes collected would be SMALL.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the Quad Cities site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

Road access to the Quad Cities site is via Illinois State Route 84, a two-lane paved road. Route 84 intersects with I-80 approximately 23 km (14 mi) south of the site. Other freeways transecting the area near Quad Cities include I-74 and I-88. The State of Illinois does not make LOS determinations in rural, nonmetropolitan areas such as at the Quad Cities site unless it is deemed necessary. Consequently, Route 84 and I-80 do not have LOS determinations calculated by the Illinois Department of Transportation (Exelon 2002b). During its site visit, the staff observed that the roads in the vicinity of the site were lightly traveled and well maintained.

The construction workforce would number 3150 (Exelon 2006). This number is in addition to the 980 permanent and contract operating employees. The permanent and contract workforce increases by roughly 1100 (for approximately 20 days) during refueling outage. QCNPS is on a 24-month refueling cycle (Exelon 2002b). Highway transport would be used in the conveyance of construction materials to the site. This would put more traffic on the roads leading to the site, resulting in congestion, particularly at shift changes. Corrective measures probably could be taken to minimize traffic congestion and safety hazards, such as using multi-shift workforces. Once the employees reached the vicinity of the Quad Cities site, they could easily disperse throughout the region on the interstates and state routes traversing the area. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on transportation would be SMALL, if impacts are actively mitigated, to MODERATE, if mitigation does not take place.

Up to an additional 580 cars on the road for operating employees of a new nuclear unit plus the 980 operating QCGS employees and 1100 temporary refueling workforce (assuming a single occupant per car) would not materially increase the congest the highway except at shift changes. These impacts could be mitigated by staggering the shift changes between the plants (currently operating at the Quad Cities site and a new unit). Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of operation on transportation would be SMALL and could be mitigated.

Aesthetics and Recreation

Topographic relief at the Quad Cities site is low and relatively flat. The station elevation represented by the ground-floor level of the reactor building is 182 m (595 ft) above MSL. The ground surface drops off abruptly at the bank of the Mississippi River, forming a bluff about 9 m (30 ft) high. The station is located on a 331-ha (817-ac) tract of land[a] and has a 94-m (310-ft) cooling tower (Exelon 2006).

That part of the site that has not been developed has slightly undulating to flat terrain and is lightly wooded with scrub oak and other trees. The trees are of small diameter, which would indicate that at one time bigger trees were harvested from the site.

The Quad Cities site is in a predominantly agricultural area. The area around the site is sparsely populated. There are some residential homes on large lots along the Mississippi River due south of the plant boundary.

The upper Mississippi River's aquatic resources in the vicinity of the Quad Cities site are diverse and abundant. The overall fish biodiversity of the Upper Mississippi River has been persistent and resilient. Recreational fishing takes place on the river, and two popular gamefish, walleye and hybrid striped bass, have increased in the vicinity since 1985 as a result of a stocking program carried out by Southern Illinois University and Exelon (Exelon 2006).

(a) It appears that when Exelon purchased the six reactor sites in Illinois that are now being considered as alternatives to the proposed ESP site, land deemed to be excess was sold off. In the case of the Quad Cities site, a fairly large parcel of land, located due east and across Route 84 from the Quad Cities site, was sold within the last 18 to 24 months (from the date of the March 4, 2004, site visit). The land is currently in agricultural production and, if not sold, could have been used for construction of a new facility. Even without this acreage, the staff's observations during the March 4, 2004, site visit suggested that sufficient land exists on the current site to construct and operate a new facility.

The Quad Cities generating facilities are not generally visible from the main-access highway, but the plume from the cooling tower is visible from some distance, given the right meteorological conditions. Exelon assumed that a new nuclear facility would have roughly the same general environmental impact as the existing facility (Exelon 2006). An additional visible plume could result from the heat-dissipation system of a new facility.

A new facility probably would have visual impacts similar to those of the existing operating units at Quad Cities. There would be minor impacts on aesthetic quality for nearby residences, which are located in an agricultural area. Cooling tower plumes from a new unit would be visible under certain meteorological conditions in addition to plumes from the existing cooling tower. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on aesthetics and recreation would be SMALL and that additional mitigation would not be warranted.

Housing

Since 1970, Rock Island County has experienced a decline in population. The 10.4 percent population decline between 1980 and 1990 was directly related to the faltering economy of the region. There has been a shift from dependence on heavy industry and manufacturing to nonprofessional service provision and retail trade. Because the younger population is leaving the County and the area, accommodations for population growth through increases in available housing has not been a concern (Exelon 2002b). In 2000, in the three counties of Rock Island and Whiteside Counties, Illinois, and Scott County, Iowa, there were 155,163 housing units, 8433 of which were vacant (5.4 percent). In the Quad Cities metropolitan area, consisting of the cities of Davenport and Bettendorf, Iowa, and Rock Island, Moline, and East Moline, Illinois, there were 100,411 housing units, with 5663 vacant houses (5.6 percent) (USCB 2000f).

Most of the construction workers for a new unit are assumed to come from within the region and commute to the job site. Thus, relatively few workers would be expected to move and take up residence in the area, and those that did could find housing within the six-county area.

If built, the ESP facility would have up to 580 employees when operational (Exelon 2006). There are 980 permanent and contracting operating personnel, approximately 77 percent of whom live in Rock Island and Whiteside Counties (Illinois) or in Scott County (Iowa) (total population 368,695) (USCB 2000f; Exelon 2002b). If 77 percent (or approximately 445) of the new employees and their families were to locate in these three counties, there would be an increase in population of approximately 1780 (assuming a family of four for each worker), or an increase in the population of the three-county area of 0.46 percent.

Most of the construction and operation workforce is expected to already be in the region and have residences in the region. Should this be the case, there would be little increase in demand for housing as a result. If the workers were not already in the region and some decided to relocate, the area would have a sufficient number of housing units to accommodate any relocations. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on the availability of housing would be SMALL and that mitigation would not be warranted.

8.5.4.6 Historic and Cultural Resources

The impacts of construction and operation of a new facility on historic and cultural resources are discussed generically in Section 8.6.5.

8.5.4.7 Environmental Justice

Exelon followed NRC guidance (NRC 2001) in applying environmental justice criteria in its ER for license renewal of the Quad Cities facility (Exelon 2002b). The NRC staff has reviewed the analysis using updated NRC guidance (NRC 2004a; 69 FR 52040).

The 2000 Census and block groups were used for ascertaining environmental justice issues for minority populations for license renewal and the 1990 Census and census tracts were used for low-income environmental justice issues. Based on the "more than 20 percent or exceeds 50 percent criteria," no American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander and no multi-racial minorities live in the geographic area. Based on the "more than 20 percent" criterion, Black Races minority populations live in 23 block groups (out of 637). Based on the "more than 20 percent" criterion, "All Other Single Minorities" minority populations exist in three block groups. Based on the "exceeds 50 percent" criterion, the aggregate of minority races populations exist in 33 block groups. Based on the "more than 20 percent criterion, Hispanic Ethnicity minority populations live in 12 block groups (Exelon 2002b). For low-income populations, based on the "more than 20 percent" criterion, one census tract contains a low-income population (out of 202 census tracts) (Exelon 2002b).

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting these minority and low-income populations. Most of the minority and low-income populations are located in the Quad Cities, approximately 32 km (20 mi) south of Quad Cities, or at greater distances. Based on a review of the Quad Cities ER for license renewal and the staff's independent review of reconnaissance-level information, including a site visit on March 9, 2004, the staff concludes that the environmental justice consequences of the construction and operation of a new nuclear facility at the Quad Cities site would be SMALL and that mitigation would not be warranted.

8.5.5 Byron Generating Station

The Byron Generating Station is located in northern Illinois, 6 km (3.7 mi) south-southwest of the City of Byron (population 2917), 27 km (17 mi) southwest of Rockford, Illinois (population 150,115), 3.5 km (2.2 mi) east of the Rock River, in Ogle County (USCB 2000g) and approximately 112 km (70 mi) west of downtown Chicago. DeKalb, Illinois (population 39,018), is approximately 45 km (28 mi) southeast of the plant (USCB 2000g). The site is situated in the approximate center of Ogle County in a predominantly agricultural area (Exelon 2006).

Byron occupies approximately 721 ha (1782 ac) of land. The main site area occupies approximately 566 ha (1398 ac), while the transmission line right-of-way occupies the remaining 155 ha (384 ac). Two nuclear units are in operation at the site and their two 151-m (495-ft) cooling towers dominate the site. The total footprint for the plant itself is approximately 40 ha (100 ac). The Rock River provides source and receiving waters. There are no industrial, institutional, commercial, recreational, or residential structures on the site, other than those used by Exelon in the normal conduct of its utility business. The development of the site for uses other than power generation and agriculture is not planned (Exelon 2002c). Exelon assumed that a new nuclear facility at the site would have roughly the same general environmental impact as the existing facility. The station utilizes closed-cycle cooling tower system with the Rock River as the source and receiving waters.

8.5.5.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Land use within the 8-km (5-mi) radius of the Byron site is agricultural. There is little industry in the vicinity, and what exists primarily supports the agrarian economy. Wheat, corn, and soybeans are the primary products. The principal land use in the region of the site is also agriculture (Exelon 2002c; AEC 1974b).

In its ER, Exelon states that the Byron site does not have additional available land within its boundaries to build a new nuclear unit. An operating unit would need to be decommissioned and dismantled so that the new nuclear unit could be constructed on the decommissioned unit's footprint (Exelon 2006).

The footprint of a new plant would be about 41 ha (100 ac) (Exelon 2006) and after visiting the Byron site on March 10, 2004, the NRC staff believes that the facility could be configured to fit within the existing 566 ha (1398 ac) of the main site. Overall, the land-use factors of construction and operation of a new nuclear unit are not particularly site-dependent. The staff concludes that potential land-use impacts associated with site-preparation and construction and operation of a new unit at the Byron site would be SMALL.

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in determination of environmental preferability. Therefore, these impacts are discussed generically in Section 8.6.1.

Byron is connected to the electric grid via 86 km (54 mi) of transmission line rights-of-way that cover about 800 ha (1977 ac) (NRC 1996). When the two existing nuclear units were constructed, these rights-of-way crossed primarily agricultural land (83 percent), mixed forest and field (9 percent), and forest (7 percent) (AEC 1974b).

The existing transmission lines serving Byron are assumed not to have the capacity to carry the power that would be generated by a new nuclear unit at the site. It is likely that new transmission lines and possibly additional rights-of-way would be needed. The additional transmission lines could be installed via expansion of an existing right-of-way, which the staff believes to be the likely scenario, or could follow a new corridor. Assuming that any transmission system modifications would be expansions of existing rights-of-way for reasons similar to those discussed in Chapters 4 and 5 for expansion to support the Exelon ESP site, the staff concludes that the land-use impacts associated with the expansion would be SMALL. The procedures for adding the new transmission lines to connect a new nuclear unit at the Byron site to the transmission grid would be similar to those described in Section 3.3.

8.5.5.2 Hydrology, Water Use, and Water Quality

The staff assumed a new nuclear unit at Byron would use wet cooling towers and withdraw makeup water from the Rock River. The staff estimated the 7Q10 (7-day average minimum annual flow) and 30Q2 (median 30-day minimum annual discharge) based on data from USGS stream gauge 05443500 on the Rock River at Como, Illinois. Data for the period of record from 1914 through 2003 were used to estimate the 7Q10 and 30Q2 values. This gauge is slightly downstream of Byron. The drainage area upstream of the gauge is reported by the USGS to be 22,670 km^2 (8753 mi^2), whereas the drainage area upstream of the site was estimated to be 20,717 km^2 (7999 mi^2). The 7Q10 and 30Q2 values estimated by staff are 26.2 m^3/s (927 cfs) and 47.3 m^3/s (1670 cfs), respectively. The net consumptive loss for a wet cooling tower, based on the PPE, is 2.0 m^3/s (70 cfs) or 7.6 and 4.2 percent of the Rock River 7Q10 and 30Q2, respectively.

Any releases of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality is protected. Based on the requirements of the current Byron NPDES permit and the above analysis, the staff concludes that the water use and water quality impacts of an additional unit at the Byron site would be SMALL.

8.5.5.3 Terrestrial Resources Including Endangered Species

Before construction of the existing plant, the Byron site was mainly an agricultural area (50 percent crop land), containing smaller areas of grassland and fallow fields (about 35 percent) and remnant forest (about 15 percent) (AEC 1974b).

Byron Generating Station is connected to the electric grid via 80 km (50 mi) of transmission lines (AEC 1976b) covering 800 ha (1977 ac) (NRC 1996). These lines cross primarily agricultural land (83 percent), mixed forest and field (9 percent), and forest (7 percent) (AEC 1974b). It is assumed that these transmission lines do not have the capacity to carry the power that would be generated by a new unit at the Byron site, and it is likely that new transmission lines and, thus, expanded rights-of-way would be needed.

There are 30 State-listed threatened or endangered terrestrial species known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Byron site, and one that occurs within 3.2 km (2 mi) (redroot [*Ceanothus ovatus*]) (IDNR 2004c).

Construction Impacts

The staff assumed that structures for new facility (power block structures, normal heat-sink cooling towers, switchyard expansion, new intake structures, and safety-related cooling towers) would be constructed primarily in agricultural/fallow field areas of the Byron site, where possible, with minimal impacts to remnant forest or grassland. Consequently, terrestrial ecological impacts from construction of a new nuclear unit at the Byron site would be negligible.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would result in expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Based on this assumption, a loss of at least 57 ha (140 ac) of forest would be anticipated. Terrestrial ecological impacts associated with the upgrade would be expected to be negligible because most of the land cover is agricultural and because loss of this amount of forest over 86 km (54 mi) of corridor would be insignificant.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial resources from construction of a new nuclear unit at the Byron site and construction associated with possible upgrade of the existing Byron transmission system would be SMALL.

Operational Impacts

Impacts on terrestrial ecological resources from operation of a new nuclear unit at the Byron site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There are four Federally listed threatened or endangered terrestrial species that may occur in the vicinity of the Byron site and the transmission lines: Indiana bat (*Myotis sodalis*), bald eagle (*Haliaeetus leucocephalus*), eastern prairie fringed orchid (*Platanthera leucophaea*), and prairie bush clover (*Lespedeza leptstachya*) (FWS 2004a). Of these four species, designated critical habitat exists only for the Indiana bat (FWS 1976).

The endangered Indiana bat potentially occurs throughout Illinois where forest habitat is present (FWS 2004a). The only critical habitat for the Indiana bat in Illinois is the Blackball Mine in LaSalle County (FWS 1976). It is unlikely that the Indiana bat occurs on the Byron site because the preponderance of the site is unforested (AEC 1974b).

The threatened bald eagle is known to nest and winter along large rivers, lakes, and reservoirs in Ogle County (FWS 2004a). However, there are no known bald eagle occurrences within 16 km (10 mi) of the Byron site (IDNR 2004c).

The threatened eastern prairie fringed orchid occupies wet grassland habitats and may occur in Ogle County (FWS 2004a); however, it is not known to occur within 16 km (10 mi) of the Byron site (IDNR 2004c).

The threatened prairie bush clover occupies dry to mesic prairies with gravelly soil (FWS 2004a) and is known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Byron site (IDNR 2004c). It is unlikely that the prairie bush clover occurs on the Byron site due to a preponderance of agricultural habitat and a paucity of prairie habitat.

Consequently, impacts to Federally listed species from construction of a new nuclear unit on the Byron site and possible expansion of the transmission line rights-of-way would be minimal.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on threatened and endangered species from construction of a new nuclear unit at the Byron site and construction associated with possible upgrade of the existing Byron transmission system would be SMALL.

8.5.5.4 Aquatic Resources Including Endangered Species

The two operating units at Byron draw makeup water from the Rock River for cooling system operation and discharge blowdown from cooling towers to the same river. Water from the Rock River would likely serve these functions for any new nuclear unit placed on the site (Exelon 2006). The Rock River contains populations of recreational sport fish, including channel catfish, walleye, northern pike, largemouth and smallmouth bass, sauger, white bass, bluegill, flathead catfish, drum, and bullheads. A limited number of commercial fishing contracts are available on the Rock River for carp, big mouth buffalo, freshwater drum, suckers, carpsuckers, gar, bowfin, grass carp, Asian carp, and gizzard shad (IDNR 2004a).

Construction Impacts

The construction of a cooling-water intake structure and discharge would be necessary if a new nuclear unit were to be located at the Byron site. Sport and commercial fisheries and other aquatic organisms and habitats would only be temporarily affected by construction. It is expected that the disturbance to aquatic resources from construction would be localized and of relatively short duration.

The NRC staff reviewed the information provided by Exelon and concludes that the environmental impacts of construction of a new nuclear unit on aquatic resources at the Byron site would be SMALL.

Operational Impacts

The aquatic impact most likely to occur as a result of operation of a new nuclear reactor at the Byron site is impingement and entrainment of organisms from the Rock River. Any new nuclear unit at the Byron ESP site would be required to meet the new EPA Phase I regulations, which is likely to require closed-cycle cooling. Operation of the new ESP unit utilizing closed-cycle cooling would withdraw little water from the Rock River, resulting in little impingement and entrainment loss.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the potential for adverse impacts to aquatic resources from operation of a new nuclear unit at the Byron site would be SMALL.

Threatened or Endangered Species

No Federally protected aquatic species are found in the vicinity of the Byron site (Sackschewsky 2004). Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact to the Federally listed threatened or endangered species from construction and operation of a new nuclear unit at the Byron site would be SMALL.

8.5.5.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new nuclear unit at the Byron site. The evaluation assesses impacts of construction and operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of the construction and operation of a new nuclear unit are similar for each of the alternative sites. They are discussed generically in Section 8.6.4.

Demography

Construction and operation would generate up to 3150 and 580 jobs, respectively. However, the increases, when compared to the total population base in the region, would be minimal. Any multiplier effects resulting from construction and operations workers' expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity. Most of the construction and operations workers are expected to come from within the region. Even if all the construction and operations workforce were to relocate to the region, they would represent a small percentage increase in the total population base. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on population within the region would be SMALL and that no mitigation would be warranted.

Impacts to the Community - Social and Economic

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the Byron site. Some of the impacts of construction and operation of a new nuclear unit that are generic are discussed in Section 8.6.4.

Economy

Byron lies near the Rock River in Ogle County, Illinois. Ogle County's business profile is led by manufacturing (37 percent of the county's total employment), followed by retail trade

(11 percent) and wholesale trade (8 percent) (USCB 2001d). The unemployment rate for Ogle County in 2000 was 4.3 percent, the same as for the State of Illinois (IDES 2000a, 2000b).

In neighboring DeKalb County, the business profile is led by manufacturing (24 percent of the county's total employment), followed by retail trade (17 percent), and health care and social assistance (15 percent) (USCB 2001e). The unemployment rate in DeKalb County was 3.6 percent in 2000 (IDES 2000b).

The magnitude of the economic impacts would be diffused within the larger economic base of the surrounding counties. In Ogle County, the existing Byron units contribute significantly to the tax base (see discussion under "Taxes" below). By inference, the same would be expected in the other economic contributions to the county's economy. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and station operation on the economy of the region would be beneficially SMALL in all counties, except Ogle County where it could be beneficially MODERATE.

Taxes

Taxes collected as a result of constructing and operating a new nuclear unit at the Byron site would be of benefit to the State and to the local jurisdictions that collect and spend them. A new nuclear unit would pay annual property taxes to Ogle County. For the tax year 2003 to 2004, the Byron Generating Station was responsible for about 30 percent of the total property taxes paid in Ogle County.[a]

Personal and corporate income taxes and sales and use taxes would also be collected over the construction and operating period a new nuclear unit. While large in absolute amount, the amounts collected would be small when compared to the total taxes collected by Illinois and by Ogle County. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of station construction on taxes collected would be SMALL. The staff also concludes that the beneficial impacts of station operations on taxes collected would be SMALL, to MODERATE for Ogle County, depending on the impacts of deregulation.[b]

(a) Personal communication, John Coffman, Ogle County, Illinois, Treasurer, May 28, 2004.
(b) The MODERATE impact is based on the impact of deregulation at Clinton Power Station (see Section 2.8.2.2). While the facility would potentially operate in a deregulated environment, the impacts of deregulation on the facility's value, and thus property taxes paid by the facility, are not fully known. Given the facility's potential value and property taxes paid to Ogle County, the staff assumed that the facility's impact on collected property taxes would, at a minimum, be SMALL and could be MODERATE when compared to the taxes the facility could pay and the total property taxes collected by the county.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the Byron site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

Illinois SR 2, which is the closest major highway to the site, is located 4 km (2.5 mi) west of the plant and has an annual average traffic flow per 24-hour period that ranges from 4000 cars between the cities of Byron and Oregon to 8800 cars in Oregon. SRs 72 and 64 are also well traveled, having 24-hour annual averages of approximately 2000 cars (Exelon 2006). A railroad spur to the site exists. Interstate-39 (U.S. Highway 51) runs near the site, connecting LaSalle to the south with Rockford on the north. U.S. Highway 51 continues south from LaSalle to the Bloomington-Normal area and Decatur. In addition, there are approximately 1000 temporary employees at the site during outages.

The construction workforce would number 3150 (Exelon 2006). This number is in addition to the 780 estimated operating employees for Byron Units 1 and 2. In addition, there are approximately 1000 temporary employees during refueling outages. If the construction of a new nuclear unit at Byron were to follow past practices (when Byron Units 1 and 2 were constructed), then heavy loads could be expected to be transported to the site by rail, with highway transport the most widely used. Corrective measures, such as using multi-shift workforces, traffic control zones, and flagging, probably would need to be taken to minimize traffic congestion and safety hazards.

The NRC staff observed highway traffic around Byron during its site visit on March 10, 2004. The addition of approximately 3150 cars (assuming a single occupant per car), in addition to the approximately 780 cars of the existing operations workforce, and the 1000 cars of the temporary refueling outage workforce on the road leading to the site could cause congestion, particularly at shift changes, and could be exacerbated with the addition of trucks carrying construction materials to the site. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction on transportation would be SMALL if the impacts are actively mitigated to MODERATE if they are not.

With respect to the operation of a new nuclear unit, adding up to an additional 580 cars (assuming a single occupant per car) to the existing 780 cars and the 1000 cars of the temporary refueling outage workforce on the road would not congest the highway except at shift changes. These impacts could be mitigated by staggering the shift changes between the current units and the new unit. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of operation on transportation would be SMALL.

Aesthetics and Recreation

The topography of the site is characterized by the northern half being dissected and sloping generally to the north. In the southern half of the site, the land is more dissected and rolling; it slopes to the southwest. The northern portion of the site is generally wooded, with some crop land near the boundary; the southern half is largely crop land. During the site visit on March 10, 2004, the staff observed that the topography of the site was generally sloping toward the Rock River.

There are several recreational facilities in the low-population zone, which for the Byron site is defined as a 4.8-km (3-mi) radius around the site. Peak daily usage of these facilities occurs on the weekends. The Rock River is the major waterway for the area surrounding the Byron site and is a popular recreation spot (Exelon 2006).

Construction of a new nuclear unit is not expected to have major impacts on the Rock River due to the distance of the site from the river (over 3.2 km [2 mi]). Any impacts to the river due to construction of an additional cooling-water structure, if needed, would be transitory. The main visual impacts of the site are the cooling towers for Units 1 and 2. Given certain meteorological conditions, the plumes from the towers can be seen for miles. The addition and operation of a new nuclear unit at Byron would most likely also require a cooling tower. This would add marginally to the visual impacts of the existing towers. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of station construction and operation on aesthetics and recreation would be SMALL and that mitigation would not be warranted.

Housing

In 2000, in the three-county area around Byron (Ogle, Winnebago, and DeKalb Counties), there were a total 167,812 housing units, of which 8880 units were vacant (5 percent) (USCB 2000g). Winnebago County, where the City of Rockford is located, had 6424 vacant units in 2000. If the past experience of the construction of Byron holds, most of the construction workers would come from within the region and commute to the job site. The site is fairly close to northwest metropolitan Chicago and Rockford and accessible via major highways and interstates. Relatively few workers would be expected to move and take up residence in the area, and those who did could find housing within the 3-county area.

If built, a new nuclear unit at Byron would have up to 580 employees when operational (Exelon 2006). As with the other alternative sites, the operations workforce is assumed to come from within the region. If all 580 employees decided to live in one of the counties, which is highly unlikely, there would be a discernable impact on housing availability, rental rates, and housing values. Should the employees scatter out over the three counties of Ogle, Winnebago, and DeKalb, which is a more likely scenario, then the chances of these impacts occurring would be lessened. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on housing would be SMALL and that mitigation would not be warranted.

8.5.5.6 Historic and Cultural Resources

The impacts of construction and operation of a new nuclear unit at the Byron site on historic and cultural resources are discussed generically in Section 8.6.5.

8.5.5.7 Environmental Justice

The staff used the GEn&SIS database to develop maps of minority and low-income populations around the Byron site (GEn&SIS 2004). The data used are based on the 2000 Census, used census blocks, and followed the NRC criteria for determining the presence of minority or low-income populations (NRC 2004a; 69 FR 52040). Maps were created showing census blocks of minority and low-income populations within 80 km (50 mi) of the site.

There is a concentration of minority populations located southwest of the Byron site, near the Town of Dixon. Another concentration of minority populations lies in Rockford, Illinois, and another directly east of Rockford at Harvard. There is another concentration of minority population northwest of the site at Freeport. The Chicago area to the northeast has numerous concentrations of minority populations. There is a concentration of low-income populations around Malta, southeast of Byron, and in Rockford.

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting minority and low-income populations. Therefore, based on the staff's independent review of reconnaissance-level information, including a site visit to Byron on March 9, 2004, the staff concludes that the environmental justice consequences of construction and operation of a new nuclear unit would be SMALL and that mitigation would not be warranted.

8.5.6 Zion Generating Station

Both units at Zion Generating Station permanently ceased operation in 1998. The units are currently in SAFSTOR with active decontamination and dismantling scheduled to begin in 2014. The generators are still in place and have been converted to synchronous condensers to stabilize system voltage (Exelon 2003b). The Zion site is located at the extreme eastern edge of the City of Zion (population 22,866) in Lake County Illinois, on the west shore of Lake Michigan. It is approximately 5 km (3 mi) south of the Illinois-Wisconsin state line, 67 km (42 mi) south of Milwaukee, Wisconsin (population 596,574), about 13 km (8 mi) south of Kenosha, Wisconsin (population 90,352), and 10 km (6 mi) north-northeast of Waukegan, Illinois (population 87,901). Lake County (population 644,356) is in the northern suburb region of the Chicago metropolitan area (AEC 1972; Exelon 2006; USCB 2000h).

8.5.6.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Land use at the Zion site and surrounding vicinity is expected to remain industrial; however, the residential and business districts of the City of Zion are close to the site. Exelon states that Zion has enough land for a new nuclear unit, assuming the existing units are decommissioned and removed (Exelon 2006). Exelon assumes that a new nuclear unit in the area would have roughly the same general environmental impact that the Zion Generating Station had when it was operating (Exelon 2006). Based on observations made during its site visit on March 1, 2004, the staff assumes that there is not sufficient land at the existing Zion site to support use of cooling towers for normal cooling.

The terrain in the area consists of low marsh lands isolated 30 to 610 m (100 to 2000 ft) inland from the shoreline, sand beaches, and dunes. Illinois Beach State Park stretches for 10.4 km (6.5 mi) along the shore of Lake Michigan at Zion. It encompasses the only remaining beach ridge shoreline left in the state. The 1683-ha (4160-ac) park, consisting of two separate areas north and south of the Zion site, accommodates swimming, boating, picnicking, hiking, fishing, and camping (IDNR 2004b).

Additional land would need to be acquired to accommodate the footprint of cooling towers. The staff believes this would be unlikely because of the adjacent state park and close proximity to the town of Zion.

The staff concludes that the potential land-use impacts associated with site-preparation and construction and operation of a new unit at Zion would be SMALL (assuming that the existing units are decommissioned and removed).

The impacts of construction and operation of a new nuclear unit on air quality would be similar at each of the alternative sites and would not be a significant factor in the determination of environmental preferability. Therefore, these impacts are discussed generically in Section 8.6.1.

The transmission lines serving Zion were constructed to carry the load from the two Zion units, which had a combined design rating of 6500 MW(t) (ComEd 1972). These transmission lines are still in place and operational. Zion transmission line rights-of-way cover 59 ha (146 ac) (NRC 1996) and traverse farmland, unused fields and marshes, industrial land, and in some instances residential areas (AEC 1972). Therefore, the staff assumes that if a new nuclear unit were constructed at the Zion site, the existing transmission lines would be capable of carrying the load from the new nuclear unit. Should modifications to the transmission system involving new transmission lines be required, the transmission lines could be installed via an expansion of an existing right-of-way, which the staff believes is the most likely scenario, or could require new rights-of-way. Assuming that any transmission system modifications would be expansion of existing rights-of-way for reasons similar to those discussed in Chapters 4 and 5 for expansion of the Exelon ESP site, the staff concludes that the land-use impacts associated with expansion would be SMALL. The procedures for adding the new transmission lines to connect a new nuclear unit at the Zion site to the transmission grid would be similar to those described in Section 3.3.

8.5.6.2 Hydrology, Water Use, and Water Quality

The staff assumed a new nuclear unit at Zion would withdraw water for cooling from Lake Michigan. Any release of contaminants to the waters of the State of Illinois would be regulated by the IEPA through the NPDES permit process to ensure that water quality is protected. Based on the requirements of the NPDES permit and the volume of Lake Michigan, the staff concludes that the water-use and water quality impacts of an additional unit at the Zion site would be SMALL.

8.5.6.3 Terrestrial Resources Including Endangered Species

The terrestrial environment at the Zion site is a beach succession series, consisting of dunes, swales, peat bogs, and marsh, as well as zones of prairie and forest, each with its distinctive flora and fauna (AEC 1972). More than 650 species of plants have been recorded in the dunes area alone around the Zion site (IDNR 2004c). The terrain in general consists of a series of low dunes and sand ridges (former Lake Michigan sand bars) running parallel with the shore of Lake Michigan and interspersed with marshes. Further inland, there is a residuum of a tallgrass prairie. The Zion site borders Illinois Beach State Park, which serves as an outdoor laboratory for ecological research. The area comprising the Zion site and Illinois Beach State Park is unique in being the only remaining dune area in Illinois (AEC 1972).

Zion transmission line rights-of-way cover 59 ha (146 ac) (NRC 1996) and traverse farmland, unused fields and marshes, industrial land, and, in some instances, residential areas (AEC 1972). Zion transmission line rights-of-way also have adjacent woodlands and traverse a portion of Illinois Beach State Park near its western border, away from the Lake Michigan shoreline. It is assumed that the existing transmission lines would be capable of carrying the load from a new nuclear unit that would replace the two existing Zion units that would be decommissioned. However, if a transmission system upgrade involving new transmission lines was needed, it would be accomplished via expansion of the existing rights-of-way.

There are 52 State-listed threatened or endangered terrestrial species known to occur within 3.2 km (2 mi) to 16 km (10 mi) of the Zion site, and 38 that occur within 3.2 km (2 mi) (IDNR 2004c).

Construction Impacts

The staff assumed that the existing structures at the Zion site would be decommissioned and removed and that a new nuclear unit (power block structures, safety-related cooling systems, switchyard expansion, and new intake and discharge structures) would occupy the footprint of the former structures. Additional land would need to be acquired offsite for normal closed-cycle wet cooling towers. Cooling towers could hypothetically be sited in an area with relatively low or high ecological value. Consequently, terrestrial ecological impacts from construction of a new nuclear unit at the Zion site could range from minor to extensive.

For the purpose of this analysis, the staff assumed that any transmission system upgrades would result in expansions of existing rights-of-way and that such expansions would consist of doubling the current corridor width. Terrestrial ecological impacts associated with the upgrade could range from minor to extensive, depending on potential impacts to Illinois Beach State Park biota.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts on terrestrial ecological resources from construction a new nuclear unit at the Zion site and construction associated with possible upgrade of the existing Zion transmission system could range from SMALL to LARGE.

Operational Impacts

Impacts on terrestrial ecological resources from operation of a new nuclear unit at the Zion site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 8.6.

Threatened or Endangered Species

There are three Federally listed threatened or endangered terrestrial species that are known or believed to occur in the near vicinity of the Zion site and transmission lines: Karner blue butterfly (*Lycaeides melissa samuelis*), eastern prairie fringed orchid (*Platanthera leucophaea*), and Pitcher's thistle (*Cirsium pitcheri*) (FWS 2004b). There is no designated critical habitat for any of these three species (FWS 2004b). Although the endangered piping plover (*Charadrius melodus*) is not currently known from the site vicinity, designated critical habitat for the piping plover occurs adjacent to the Zion site (FWS 2004b).

The endangered Karner blue butterfly is believed to occur in Illinois Beach State Park (FWS 2004b) and is known to occur within 3.2 km (2 mi) of the Zion site (IDNR 2004c). Lupine is the sole food source of the Karner blue butterfly (FWS 2004b). This species is consequently associated with remnant barrens and savanna ecosystems, and other areas that have soils and/or management (soil disturbance or suppression of perennial shrubs and herbaceous vegetation [e.g., transmission line rights-of-way]) suitable for wild lupine (*Lupinus perennis*) growth.

The threatened eastern prairie fringed orchid is located in Illinois Beach State Park. Its habitat includes, but is not restricted to, mesic prairie, sedge meadows, marsh edges, and bogs (FWS 2004b).

The threatened Pitcher's thistle is also located in Illinois Beach State Park and is part of the dynamic dune ecosystem. Its habitat includes beach, foredune, interdunal trough, and secondary dune areas (FWS 2004b).

Portions of the lake shoreline within Illinois Beach State Park, including shoreline adjacent to the Zion site, are designated critical habitat for the Great Lakes breeding population of the piping plover.

The existing structures at the Zion site would be decommissioned and removed and a new nuclear unit, with the exception of normal closed-cycle wet cooling towers, would be constructed so as to occupy the footprint of the former structures. Cooling towers would need to be constructed offsite. Thus, none of the above three threatened or endangered species could be affected onsite, if they were to occur there. The cooling towers could hypothetically be located in an area where they may or may not affect the three threatened or endangered species and/or critical habitat. Furthermore, the three threatened or endangered species might or might not be affected by transmission system upgrades. Consequently, impacts to Federally listed species and designated critical habitat from construction of a new nuclear unit on the Zion site and possible expansion of the transmission line rights-of-way could range from minor to extensive.

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that impacts on threatened and endangered species from construction of a new nuclear unit at the Zion site and construction associated with a possible upgrade of the existing Zion transmission system could range from SMALL to LARGE.

8.5.6.4 Aquatic Resources Including Endangered Species

The Zion site is located on the western shore of Lake Michigan. Lake Michigan is characterized by low nutrient concentrations and biological productivity. Near the Zion site, inshore waters are characterized as mesotrophic or intermediate, with respect to nutrients. Although substantial declines in fish populations have occurred in Lake Michigan due to pollution and other impacts, Lake Michigan has the largest sport fishery on the Great Lakes, valued at more than $250 million annually (UW Sea Grant Institute 1998). Besides its world-class trout and salmon fisheries, the lake also supports substantial commercial whitefish and yellow perch fisheries (UW Sea Grant Institute 1998). Inshore regions that have sand-gravel bottoms are potential spawning areas for a number of fish species (AEC 1972).

Construction Impacts

The construction of a new cooling water intake structure and discharge might be necessary if a new nuclear unit were to be located at Zion. While aquatic biota, including commercial and recreational fish, would be temporarily displaced during the construction period, they would be expected to recolonize the region after construction is complete. The timing of the construction and in-water work window could help mitigate the impacts, especially if fish are spawning on the inshore sand-gravel bottom regions (ComEd 1972). It is expected that the disturbance to aquatic resources from construction would be localized and of relatively short duration.

The NRC staff reviewed the information provided by Exelon and concludes that the environmental impacts of construction of a new nuclear unit on aquatic resources would be SMALL, assuming that appropriate mitigative actions are employed.

Operational Impacts

Nothing in Zion's environmental statement or the decommissioning safety analysis report indicates that operation of a new facility at the site would adversely affect aquatic environments (ComEd 1972; Exelon 2003b). However, because fish may spawn in areas near Zion, there is the potential for adverse impacts to local aquatic habitat and biota due to impingement and entrainment. Any new nuclear unit at the Zion ESP site would be required to meet the new EPA Phase I regulations, which is likely to require close-cycle cooling. Operation of the new ESP unit utilizing closed-cycle cooling would withdraw little water from Lake Michigan, resulting in minimal impingement and entrainment loss. Therefore, the staff concludes that the environmental impacts due to operations of a new nuclear unit at the Zion site would be SMALL.

Threatened or Endangered Species

No Federally protected aquatic species are found in the vicinity of the Zion site (Sackschewsky 2004). Based on the information provided by Exelon and the NRC staff's independent review, the staff concludes that the overall impact on Federally listed threatened or endangered species from construction and operation of a new nuclear unit at the Zion site would be SMALL.

8.5.6.5 Socioeconomics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing and operating a new unit at the Zion site. The evaluation assesses impacts of construction and station operation and of those demands placed by the workforce on the surrounding region.

Physical Impacts

The physical impacts of the construction and operation of a new nuclear unit are similar for each of the alternative sites. They are discussed generically in Section 8.6.4.

Demography

Construction and operation would generate up to 3150 and 580 jobs, respectively. But these increases, when compared to the total population base in the region, would be minimal. Any multiplier effects resulting from construction and operations workers' expenditures would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity. Most of the construction and operations workers are expected to come from within the region. Even if all the construction and operations workforce were to relocate to the region, they would represent a small percentage increase in the total population base. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on population within the region would be SMALL.

Impacts to the Community - Social and Economic

This subsection discusses the site-specific impacts of construction and operation of a new nuclear unit at the Zion site. Some of the impacts of construction and operation of a new nuclear unit that are generic are discussed in Section 8.6.4.

Economy

Zion is located in Lake County, Illinois, where manufacturing comprises 17 percent of the county's total employment, followed by retail trade (13 percent) and health care and social assistance (9 percent) (USCB 2001f). The unemployment rate for Lake County in 2000 was 3.7 percent, while that for Illinois was 4.3 percent (IDES 2000a, b).

Zion is less than 80 km (50 mi) from Chicago, with a current population of more than 5 million. Additionally, the Waukegan-North Chicago area is predominantly an industrial region with 144 manufacturing establishments. The product of the largest of these manufacturing firms is pharmaceuticals and chemicals. The most predominant product of the remainder is in the metallurgical and fabricated metal products field. The Zion-Winthrop Harbor area is a small industrial region. A portion of this industry, which involves light manufacturing, is located between the western boundary of the Zion site and the Chicago and Northwestern railroad tracks, approximately 1.3 km (0.8 mi) west of the plant location (Exelon 2006).

The magnitude of the economic impacts of a new nuclear plant would be diffused within the larger economic base of Lake County and the Chicago Metropolitan area. Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and operation on the economy of the region would be SMALL.

Taxes

Taxes collected as a result of constructing and operating a new nuclear unit at Zion would be of benefit to the State and local jurisdictions collecting and spending them. A new nuclear unit at Zion would pay annual property taxes to Lake County. Personal and corporate income taxes and sales and use taxes would also be collected over the construction and operating period for a new nuclear unit. While large in absolute amount, the amounts collected are small when compared to the total taxes collected by Illinois and Lake County. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the beneficial impacts of construction and operation on taxes would be SMALL.

Impacts to the Community - Infrastructure and Community

This subsection discusses the site specific impacts of construction and operation of a new nuclear unit at the Zion site concerning transportation, aesthetics and recreation, and housing. Some of the impacts of construction and operation of a new nuclear unit that are generic (such as public services) are discussed in Section 8.6.4.

Transportation

The major transportation routes near the site include Lake Michigan, which has ship and barge traffic. Due west of the site is Interstate (I) 94, which runs north-south and connects Chicago on the south with Milwaukee to the north. U.S. Route 41 parallels I-80 and SR 173 runs east to west and connects the City of Zion to Rockford, Illinois, to the west. Access to Zion is off SR 137 via Shilo Road. There is a railroad spur leading to Zion, which probably would need upgrading if a new nuclear unit were constructed at the site.

The construction workforce would number 3150 (Exelon 2006). If the construction of a new nuclear unit were to follow past practices when other nuclear units were constructed by Commonwealth Edison, the construction jobs would attract a large number of construction workers, who would commute to the site from the surrounding area (AEC 1972). Highway transport would be used in the conveyance of construction materials to the site. Railroad transportation would probably be employed for some of the heavier construction equipment and materials. There will be more traffic on the roads leading to the site, resulting in more congestion, particularly at shift changes. Corrective measures, such as using multi-shift workforces, probably could be taken to minimize traffic congestion and safety hazards.

The NRC staff observed highway traffic around Zion during its site visit on March 1, 2004. Shilo Boulevard exits onto a very busy SR 137. An additional 3150 cars (assuming a single occupant per car) on the road leading to the site could cause congestion, particularly at shift changes, and could be exacerbated with the addition of trucks carrying construction materials to the site. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction of a new unit on transportation would be MODERATE, if impacts are actively mitigated, to LARGE, if they are not.

With respect to the operations of a new unit at Zion, up to an additional 580 cars (assuming a single occupant per car) would not congest the highway except at shift changes. These impacts could be mitigated by staggering the shift changes so that shift changes would not all occur at the same time. Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of station operation on transportation would be SMALL and could be mitigated through minor actions.

Aesthetics and Recreation

Lake Michigan is the major waterway for the area and is immediately east of the Zion site. The topography of the site is generally flat. Most of the site is open. The site is bordered on the north and south by Illinois Beach State Park. There is both recreational and commercial fishing on Lake Michigan. Exelon does not anticipate that any additional land would be preempted if the site were used for a new nuclear unit (Exelon 2006). If this is the case, the wetlands and low marsh lands of the site would not be impacted. The site itself is zoned industrial (Exelon 2006).

The main aesthetic and recreational impacts would result from the construction and operation of the cooling systems for a new nuclear unit. As discussed in Section 5.4.2.1, the EPA Final Rule, as amended, on cooling water intake structures for new facilities (66 FR 65255) makes it unlikely that a new nuclear unit will employ once-through cooling on the Great Lakes. In addition, based on observations made during their March 1, 2004, site visit, the staff assumed that insufficient land exists at Zion to support the use of new cooling towers for the proposed new unit. Therefore, based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of station construction and operation on aesthetics and recreation at the Zion site would be SMALL and that mitigation would not be warranted.

Based on the information provided by Exelon and the staff's independent review, the staff concludes that the impacts of station operation on aesthetics and recreation would be SMALL and that mitigation is not warranted.

Housing

In Lake County, there are 225,919 housing units, of which 9622 units (4.3 percent of the total) are vacant. To the south, Cook County (Chicago) has 2,096,121 total housing units of which 121,940 are vacant, or 5.8 percent (USCB 2000h). Most of the construction workers (if the past experience holds on the construction of several other nuclear power plants that Exelon owns) would come from within the region and commute to the job site. Most of the construction workers hired for the initial construction of Zion probably came from the Chicago, Milwaukee, and Kenosha metropolitan areas and commuted to the Zion site. Thus, with the construction of a new nuclear unit, relatively few workers would be expected to move and take up residence in the area, and those who did could find housing within the metropolitan areas.

If built, a new nuclear unit at the Zion site would have up to 580 employees when it is operational (Exelon 2006). If all employees decided to live in either Lake or Cook County, the staff would not expect to see a discernable impact on housing availability, rental rates, or housing values. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operation on housing would be SMALL and that mitigation would not be warranted.

8.5.6.6 Historic and Cultural Resources

The impacts of construction and operation of a new nuclear unit on historic and cultural resources at the alternative sites are discussed generically in Section 8.6.5.

8.5.6.7 Environmental Justice

The staff used the GEn&SIS database to develop maps of minority and low-income populations around the Zion site (GEn&SIS 2004). The data used are based on the 2000 Census, used census blocks, and followed the NRC criteria for determining the presence of minority or low-income populations (NRC 2004a; 69 FR 52040). Maps were created showing census blocks of minority and low-income populations within 80 km (50 mi) of Zion.

There are concentrations of minority populations located north of the Zion site in Milwaukee, Racine, and Kenosha, Wisconsin. One concentration of minority populations lies due west of the Zion site, another due south of the site toward Waukegan and North Chicago, and a third, a very large concentration, along Lake Michigan and near the Illinois-Indiana State line.

For low-income populations, there are large concentrations in Milwaukee and within the Chicago metropolitan area, particularly along Lake Michigan and near the Illinois-Indiana State line.

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, the staff did not identify or observe any location-dependent disproportionate impacts affecting these minority and low-income populations. Therefore, based on the staff's independent review of reconnaissance-level information, the staff concludes that environmental justice consequences of construction and operation of a new nuclear unit at Zion would be SMALL and that mitigation would not be warranted.

8.6 Issues Among Sites Handled Generically

In evaluating the alternative sites, the NRC staff identified several areas where the potential impacts of construction and operation of new nuclear power plants would be sufficiently similar to the proposed and alternative sites that detailed site-specific evaluation of the potential impacts would be unlikely to contribute to the determination that one or more of the alternative sites is environmentally preferable to the proposed site. These areas, which include nonradiological health impacts, radiological impacts of normal operation, cultural and historic resources, and impacts on public service facilities are addressed in this section.

8.6.1 Land Use and Air Quality

Land use has been covered in the sections for each of the alternative sites because the variation among the sites is sufficiently large that a generic discussion was not appropriate.

Air quality impacts of construction and operation of a new nuclear unit would likely be similar at the proposed ESP site and the alternative sites. The construction impacts would include dust from disturbed land, roads, and construction activities and emissions from construction equipment. These impacts would be similar to the impacts associated with any large construction project. Exelon has discussed measures that it would take to mitigate air quality impacts at the proposed ESP site. The staff assumes that the same or similar measures would be taken if a new nuclear unit were to be constructed at any of the alternative sites. The staff concludes that air quality impacts of construction of a new nuclear unit at the alternative sites likely would be SMALL.

For purposes of the evaluation of alternative sites, the staff assumes that the air quality impacts of emissions from vehicles used for construction worker transportation likely would be SMALL at all sites. However, the Braidwood, Dresden, and Zion sites are located in areas that have been designated by the EPA as “nonattainment” relative to both the 1-hour and 8-hour national ambient air quality standards for ozone (40 CFR 81.314). Additional analysis would be required to verify that the significance level for air quality impacts of construction worker transportation would be SMALL should one of these sites be determined to be environmentally preferable to the proposed ESP site.

Impacts of operation of a new nuclear plant on air quality are related primarily to the operation of standby generators, boilers, and cooling towers. The operation of standby generators and boilers is independent of the site. Similarly, the quantity of cooling tower drift is a function of cooling tower design, not the site. The staff assumes that Exelon would comply with all regulations related to emissions from generators and boilers and that cooling towers would use current technology to minimize drift. On these bases, the staff concludes that the impacts of operation of a new nuclear unit at the alternative sites on air quality would be SMALL.

8.6.2 Terrestrial Ecology

Terrestrial ecological impacts that may result from operation of a new nuclear unit at the alternative sites include those associated with cooling towers, transmission system structures, and maintenance of transmission line rights-of-way. An evaluation of impacts resulting from operation of cooling towers and transmission lines and transmission line right-of-way maintenance cannot be conducted in any detail due to missing information, such as the type, number, and specific location of cooling towers at each alternative site, and the number of new transmission lines and locations of any new rights-of-way that could result from transmission system upgrades. Consequently, conclusions in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437 (NRC 1996) were used to assess terrestrial impacts resulting from the operation of cooling towers.

The GEIS (NRC 1996) evaluated terrestrial ecological impacts resulting from operation of existing nuclear power plants. Because the types of terrestrial ecological impacts resulting from operation of a new nuclear unit would be similar to those of existing nuclear power plants, the GEIS (NRC 1996) is useful for this analysis.

For impacts resulting from transmission line operation and transmission line right-of-way maintenance, the staff assumed that the existing transmission lines at the alternative sites would not have the capacity to carry the power that would be generated by a new nuclear unit. The staff also assumed that any transmission system upgrades would require the addition of new lines that would result in expansions of the existing rights-of-way and that such expansions would consist of doubling current corridor widths. Given these assumptions, conclusions in the GEIS (NRC 1996) were used for impacts resulting from transmission line operation and transmission line right-of-way maintenance.

Cooling Towers

Impacts on crops, ornamental vegetation, and native plants from cooling tower drift cannot be evaluated in detail in the absence of information on the type (mechanical or natural draft), number, and specific location of cooling towers at each alternative site. Similarly, bird collisions with cooling towers cannot be evaluated in the absence of information on the type (mechanical or natural draft for a wet cooling system; dry for a dry system) and number of cooling towers at each alternative site. However, all of the alternative sites are the sites of existing power plants. The impacts of cooling tower drift and bird collisions for existing power plants were evaluated in NUREG-1437 (NRC 1996) and found to be of minor significance for all plants, including those with various numbers and types of cooling towers. In addition, the staff concluded that no additional mitigation was warranted for the existing cooling towers. On this basis, the staff concludes, for the purpose of comparing the alternative sites, that the impacts of cooling tower drift and bird collisions with cooling towers resulting from operation of a new nuclear unit at all of the alternative sites would be minor.

For both natural and mechanical draft cooling towers, the anticipated noise level from cooling tower operation is anticipated to be 55 decibels on the A scale (dBA) at 305 m (1000 ft) (Exelon 2006). The noise level for dry cooling towers is somewhat higher. This noise level is well below the 80- to 85-dBA threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus, noise from operating cooling towers at any of the alternative sites would not be likely to disturb wildlife beyond 305 m (1000 ft) from the source.

Further, impacts within this distance would be considered negligible because no important terrestrial species (as defined in NRC 2000) are known to occur on any of the alternative sites. Consequently, the staff concludes that the impacts of cooling tower noise on wildlife would be minimal at all the alternative sites.

Transmission Lines

The impacts associated with transmission line operation consist of bird collisions with transmission lines and electromagnetic field (EMF) effects on flora and fauna. The impacts associated with right-of-way maintenance activities are loss of habitat due to cutting and herbicide application, and similar impacts where rights-of-way cross floodplains and wetlands.

Bird collisions with transmission lines are of minor significance at operating nuclear power plants, including transmission line rights-of-way with variable numbers of power lines (NRC 1996). Thus, although additional transmission lines would be required for a new nuclear unit at the alternative sites, these would likely present few new opportunities for bird collisions. The additional number of bird collisions, if any, would not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by the addition of new transmission lines for a new nuclear unit would be negligible at all the alternative sites.

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). A careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures (NRC 1996). The impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines (NRC 1996). Since 1997, over a dozen studies have been published that looked at cancer in animals that were exposed to EMFs for all or most of their lives (Moulder 2005). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2005). Therefore, the incremental EMF impact posed by addition of new transmission lines for a new nuclear unit would be negligible at all the alternative sites.

Existing roads providing access to the existing transmission line rights-of-way at the alternative sites would likely be sufficient for use in any expanded rights-of-way and no new roads would be required. It is assumed that the same vegetation management practices currently employed to maintain the existing rights-of-way at the alternative sites would be applied to any expanded rights-of-way associated with a new nuclear unit. Thus, vegetation management would occur along the same rights-of-way, but over twice the area. Transmission line right-of-way management activities (cutting and herbicide application) and related impacts on floodplains and wetlands in transmission line rights-of-way are of minor significance at operating nuclear power plants, including those with transmission line rights-of-way of variable widths

(NRC 1996). Consequently, the incremental effects of transmission line right-of-way management and associated impacts to floodplains and wetlands posed by doubling the widths of the existing rights-of-way for a new nuclear unit would be negligible at all the alternative sites.

Conclusion

Based on information provided by Exelon and the NRC staff's independent review, the staff concludes that the impacts from operation of a new nuclear unit (including cooling towers, transmission lines, and transmission line rights-of-way) to terrestrial ecology at any of the alternative sites would be SMALL.

8.6.3 Aquatic Ecology

Aquatic ecological impacts that may result from construction and operation of a new nuclear unit at the alternative sites include those associated with cooling water intake, consumption, and water discharge. A detailed evaluation of impacts resulting from operation of a new nuclear unit cannot be reasonably conducted due to missing information. However, all of the alternative sites are located at the sites of existing power plants. Operational impacts resulting from continued operation of an existing plant are likely to be similar to operational impacts from a new nuclear plant. Ten operational impacts of cooling water systems on aquatic ecology (including issues concerning gas supersaturation, water quality, nuisance organisms, and others) were determined to be applicable to current operating nuclear power plants and were evaluated in NUREG-1437 (NRC 1996). These impacts were found to be SMALL for all current operating plants, and the staff concluded that no additional mitigation was warranted for these issues.

However, other potential impacts of water intake and discharge systems on aquatic ecosystems at nuclear power plants depend on site-specific factors and on factors related to specific features of the design and construction of these systems. Therefore, a generic discussion of impingement and entrainment of fish and shellfish and of heat shock is not appropriate, and these impacts are discussed separately for each of the alternative sites.

8.6.4 Socioeconomics

There are several socioeconomic areas where generic treatment of issues related to construction and operation of a new nuclear unit is reasonable. These areas fall within the general categories of physical impacts and community characteristics. Demography and the remaining areas relating to physical impacts and community characteristics are discussed separately for each of the alternative sites.

Physical Impacts

Many of the physical impacts of construction and operation would be similar regardless of the sites.

Workers and Local Public

The physical impacts of construction would be similar at all six alternative sites. People who work or live around the alternative sites could be exposed to noise, fugitive dust, and gaseous emissions from construction activities. Construction workers and personnel working onsite could be the most impacted. Air pollution emissions are expected to be controlled by applicable best management practices and Federal, State, and local regulations. All sites are zoned industrial.

During station operation, standby diesel generators used for auxiliary power would have air-pollution emissions. It is expected that these generators would see limited use and, if used, would be used for only short time periods. Applicable Federal, State, and local air-pollution requirements would apply to all fuel-burning engines. At the site boundary for most sites, the annual average exposure from gaseous emission sources is anticipated not to exceed applicable regulations during normal operations. The impacts of station operations on air quality are expected to be minimal. As with construction impacts, potential offsite receptors are generally located well away from the site boundaries.

Residential and commercial areas are located well away from the alternative site boundaries, applicable air-pollution regulations would have to be met by Exelon, and applicable best management practices would be put in place. Therefore, based on information provided by Exelon and the staff’s independent review of reconnaissance-level information, the staff concludes that the physical impacts of station construction and operation on workers and the local public would be SMALL.

Buildings

Construction activities and station operations are not expected to impact any offsite buildings. Most buildings not located onsite are well removed from the site boundaries. Buildings most vulnerable to shock and vibration from pile-driving and other related activities are those located on the alternative sites. No physical impacts to structures, including any residences near the site boundaries, would be expected. Therefore, based on the staff’s independent review of reconnaissance-level information, including visits to all the alternative sites during the period March 1 through 11, 2004, the staff concludes that the physical impacts of station construction and operation on offsite buildings would be SMALL.

Roads

During construction, an additional 3150 cars and 100 trucks per day were assumed to use the roads in the vicinity of each alternative site. This is in addition to the existing operations workforce at most of the alternative sites and the approximately 1000 temporary workers hired during refueling outages. Heavy loads of construction materials and equipment and the increased traffic might necessitate additional maintenance and repair of roads. Railroad spurs leading to some of the sites could be used for delivery of the heavier construction materials and equipment, alleviating some road damage and increased maintenance expenses. The rail spurs would most likely need upgrading to accommodate these loads. Based on the staff's independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the physical impacts of construction on roads in the vicinity of the alternative sites would be SMALL if railroad spurs were used for delivery of heavy construction materials and equipment and MODERATE if they are not.

During station operations, the roads and highways within the vicinity of the alternative sites would experience an increase of approximately 580 cars per day from the addition of operations personnel. This is in addition to the existing operations workforce for the current operating units at each of the sites, except Zion where the new units would replace existing units that are no longer operational. In addition, there are approximately 1000 temporary workers hired for refueling outages. It is expected that increased commuter traffic from station operations would not place undo wear and tear on the roads or cause them to physically deteriorate at a faster rate than they do now. Therefore, based on the staff's independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the physical impacts of operations on roads would be SMALL, and that mitigation would not be warranted.

Aesthetics

Construction at all the alternative sites could be viewed from outside the sites at certain locations. All sites, except Zion, are located in rural areas with sparse residential or commercial development near the site. Construction of cooling-water intake structures could impact the body of water within which the construction takes place. The impacts could increase suspended solids concentrations in the water bodies and fish species might be temporarily displaced as a result of minor disturbances associated with construction activities, including noise, dredging, etc. This in turn could impact recreation and recreational opportunities such as fishing. However, such impacts are transitory and are not expected to have any long-term, permanent consequences. Onsite erosion and stormwater runoff control measures would be expected to be implemented in accordance with Illinois and Federal regulations.

The sites, except for Zion, are located in rural areas. Any construction impacts on the view would be temporary. Based on the staff's independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the impacts of construction on aesthetics would be SMALL at all sites.

The aesthetic impacts of station operations would be influenced by the type of nuclear reactor and cooling system Exelon chooses. The facility might have a power block structure that is 72 m (234 ft) tall. The heat dissipation system could have a height up to 168 m (550 ft). An off-gas structure that would range in height between the power-block structure and the height of the heat dissipation system might also be required. An additional visible plume might result where cooling towers were used, particularly during cold weather (Exelon 2006). At sites already having cooling towers, the additional cooling towers would be a marginal addition to an already visually disturbed site. Based on the staff's independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the physical impacts of station operation on aesthetics would be SMALL, and that mitigation would not be warranted.

Demography

Because of the dissimilarities among the sites, the demography of each of the alternative sites has been covered in the site-specific discussions.

Impacts to the Community - Infrastructure and Community

Two aspects related to infrastructure and community impacts are sufficiently similar for all of the alternative sites that they can be discussed as generic issues: public services and education.

Public Services

Public services include water supply and waste water treatment facilities; police, fire, and medical facilities; and social services. Both construction and station operating personnel are expected to come from within the region. Those workers living outside the region would most likely commute to the job site from their residences. Any new construction employees relocating to the region would most likely be scattered throughout the region where there is available housing. New operations employees relocating from outside the region would most likely live in residentially developed areas. It is not expected that public services would be materially impacted by these workers.

There might be an increased demand for some social services for construction workers moving to the area and looking for work either at a new nuclear unit or in secondary jobs created by the construction. However, the construction and operation of the facility would have a beneficial economic impact to the economically disadvantaged, which would likely lessen the demand for social services in the longer-term.

Therefore, based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the impacts of construction and operations on public services would be SMALL, and that mitigation would not be warranted.

Education

The majority of the construction workers would be expected to come from the region, with little anticipated in-migration of construction workers from outside the region. Should there be construction workers coming in from outside the region, chances are they would commute to the construction site, stay for the week, and go back to their permanent residence on weekends. Should that be the case, there would be minimal impact from additional children being placed in the educational systems within the region.

Exelon assumes that the majority of the operations workforce would come from within the region where their educational requirements are already being met. As such, the school systems in these areas would not experience any major influx of students because of the operation of a new nuclear unit (Exelon 2006). Even if some of the operating workforce were to come from outside the region, the majority of the new workers likely would move to the more populous areas in the surrounding communities, having access to the more developed public services. Workers with school-aged children would be interested in communities with good school districts, for example.

Based on the information provided by Exelon and the staff's independent review of reconnaissance-level information, the staff concludes that the potential impacts of the facility construction and operations on education would be SMALL and that mitigation would not be warranted.

8.6.5 Historic and Cultural Resources

The alternative sites do not appear to present significant issues concerning historic and cultural resources. Information about each alternative site was obtained from a review of two final environmental impact statements, Supplements 16 (Quad Cities) and 17 (Dresden) to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437; NRC 1996), and a records review at the Illinois Historic Preservation Agency (IHPA). If one of the alternative sites were selected, consultation with the IHPA would be required to identify additional measures to be taken. Based on (1) the staff's reconnaissance-level review of information obtained from IHPA, (2) previous environmental reports, and (3) the protective measures that would be in place before and during construction and operation, the staff concludes that the impacts of construction and operation of an ESP unit on historic and cultural resources at any of the alternative sites would be SMALL.

8.6.6 Environmental Justice

The staff evaluated the environmental justice consequences of locating a new nuclear unit at each of the alternative sites and concludes that the environmental justice impacts are SMALL for each site. However, because of the importance of the site-specific factors considered in reaching these conclusions, environmental justice has been discussed for each alternative site.

8.6.7 Nonradiological Health Impacts

Nonradiological health impacts from construction of a new nuclear unit on the construction workers at the alternative sites would be similar to those evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal and State regulations on air quality and noise would be complied with during the plant construction phase. None of the alternative sites has site characteristics that would be expected to lead to fewer or more construction accidents than would be expected for any of the other alternative sites. All the alternative sites, except Zion, are in rural areas and construction impacts would likely be minimal on the surrounding population. The staff concludes that health impacts to construction workers resulting from the construction of a new nuclear unit at any of the alternative sites would be SMALL.

Occupational health impacts to operational employees would likely be the same for all the alternative sites. Thermophilic microorganisms would not be a concern at the alternative sites using either a wet or hybrid wet/dry cooling process. Health impacts to workers from occupational injuries, noise, and electric fields would be similar. None of the alternative sites has site characteristics that would be expected to lead to fewer or more operational accidents than would be expected for any of the other alternative sites. Noise and electric fields would be monitored and controlled in accordance with applicable Occupational Safety and Health Administration regulations.

The staff expects that the occupational health impacts to operations employees of a new nuclear unit at any of the alternative sites would be SMALL. Similarly, impacts to public health of a new nuclear unit's operation at the Clinton site or any of the alternative sites would be expected to be minimal. The staff concludes that the public health impacts would be SMALL.

8.6.8 Radiological Impacts of Normal Operations

Exposure pathways for gaseous and liquid effluents from a new nuclear unit on the ESP site or an alternative site would be similar. Gaseous effluent pathways include external exposure to the airborne plume, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products. Liquid effluent pathways include ingestion of aquatic foods, ingestion of drinking water, external exposure to shoreline sediments, and external exposure to water through boating and swimming.

Section 5.9 discusses the estimates of doses to the maximally exposed individual and the general population for a new nuclear unit at the proposed Exelon ESP site for both liquid-effluent and gaseous-effluent pathways. The estimated doses to the maximally exposed individual were well within the design objectives of 10 CFR Part 50, Appendix I. The same bounding liquid and gaseous effluent releases would be used to evaluate doses to the maximally exposed individual and the population at each alternative site. Even with differences in pathways, atmospheric and water dispersion factors, and population, doses estimated to the maximally exposed individual for the alternative sites would be expected to be well within the Appendix I design objectives. Population doses within 80 km (50 mi) of the proposed facility would be higher for those alternative sites closer to major population centers (i.e., Braidwood, Dresden, and Zion); however, they would still be small compared to the population dose from natural background radiation. Therefore, the staff concludes that radiation doses and resultant health impacts from a new nuclear unit's operations would be SMALL at all of the alternative sites.

Occupational doses to workers at a new unit would be the same for the alternative sites as they are for the proposed site. The advanced reactor design of a new unit would likely result in less occupational exposure annually than from current operating plants. The staff concludes that the occupational radiation doses from a new nuclear unit's operation would be SMALL for all of the alternative sites.

Table 5-5 provides the annual total body dose estimates to surrogate biota species for a new nuclear unit. Annual dose to algae and heron surrogate species exceeded the dose standard in 40 CFR Part 190. The 40 CFR 190 standards apply to members of the public in unrestricted areas and not specifically to biota. The estimates are conservative as they not do consider any dilution or decay of liquid effluents during transit. Actual doses to biota are likely to be much lower. The staff reviewed the available information relative to the radiological impact on biota other than humans, and performed an independent estimate of dose to the biota. The staff concludes that no measurable radiological impact on biota is expected from the radiation and radioactive material released to the environment as a result of the routine operation of a new nuclear unit and that the impacts to biota of radiation doses at any one of the alternative sites would be SMALL.

8.6.9 Postulated Accidents

In Section 5.10, the staff considered a suite of design-basis accidents for a new nuclear unit at the proposed Clinton ESP site. The evaluation involved calculation of doses for specified periods at the exclusion area and low-population zone boundaries, and comparison of those doses with doses based on regulatory limits and guidelines. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results would only have been due to meteorological conditions and the distances to the site boundaries. The release characteristics would have been the same at all sites.

For the Clinton site and meteorology, the doses for each accident sequence considered were well below the corresponding regulatory limits and guidelines. The general climatological conditions at the proposed site are sufficiently similar to the conditions at the alternative sites that it is highly unlikely that differences in local meteorological conditions would be sufficient to cause doses from design-basis accidents for a new nuclear unit at any of the alternative sites to exceed regulatory limits or guidelines. Similarly, because each of the alternative sites is located at an existing nuclear power site, it is unlikely that differences in distances to the exclusion area and low-population zone boundaries would be sufficient to cause doses from design-basis accidents for a new nuclear unit at any of the alternative sites to exceed regulatory limits or guidelines. Therefore, the staff concludes that for the purposes of consideration of alternative sites, the impact of design basis accidents at each of the alternative sites would be SMALL.

Section 5.10 also includes a detailed analysis of the potential consequences of severe accidents for the postulated plants for the Clinton site. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results would only have been due to site-specific factors such as meteorological conditions, population distribution, and land-use distribution. The release characteristics would have been the same at all sites.

The probability-weighted consequences estimated for severe accidents for a new nuclear unit at the proposed site are well below the consequences estimated for severe accidents at current generation reactors (see Section 5.10). This result suggests that the consequences of severe accidents at the any of the alternative sites would be less than the consequences of a severe accident at an existing plant at the site. The Commission has determined that the probability-weighted consequences of severe accidents are SMALL for all existing plants (10 CFR 51, Subpart B, Table B-1). On this basis, the staff concludes that, for the purposes of consideration of alternative sites, the impact of severe accidents at each of the alternative sites likely would be SMALL.

8.7 Summary of Alternative Site Impacts

A summary of the impacts of construction and operation of a new nuclear unit at each of the six alternative sites selected by Exelon is presented in Tables 8-5 and 8-6. Discussion of the stated impacts is presented in the individual site sections (Sections 8.5.1 through 8.5.6) and the generic impacts section (Section 8.6). A comparison of the alternative site impacts with impacts at the proposed ESP site at Clinton and with impacts of the no-action alternative is presented in Chapter 9.

Table 8-5. Characterization of Construction Impacts at the Alternative ESP Sites

Category	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Land-Use Impacts						
The site and vicinity	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Transmission line rights-of-way	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water-Related Impacts						
Water use	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological Impacts						
Terrestrial ecosystems	SMALL to LARGE[a]	SMALL	SMALL	SMALL to LARGE[b]	SMALL	SMALL to LARGE[c]
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Threatened or endangered species	SMALL to LARGE[a]	SMALL	SMALL	SMALL to MODERATE[d]	SMALL	SMALL to LARGE[c]
Socioeconomic Impacts						
Physical Impacts						
Workers and local public	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Buildings	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Roads	SMALL to MODERATE[e]	SMALL to MODERATE[e]	SMALL to MODERATE[e]	SMALL to MODERATE[e]	SMALL to MODERATE[e]	SMALL to MODERATE[e]
Aesthetics	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Impacts to the Community - Social and Economic						
Economy	SMALL to MODERATE[f]	SMALL	SMALL to MODERATE[g]	SMALL	SMALL to MODERATE[h]	SMALL
Taxes (beneficial impact)	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Table 8-5. (contd)

Category	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Impacts to the Community - Infrastructure and Community						
Transportation	SMALL to MODERATE[i]	SMALL to MODERATE[j]	SMALL to MODERATE[k]	SMALL to MODERATE[l]	SMALL to MODERATE[m]	MODERATE to LARGE[n]
Aesthetics and recreation	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Housing	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Public and social services and infrastructure	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Related to transmission system upgrades. See Section 8.5.1.3.
(b) Related to transmission system upgrades. See Section 8.5.4.3.
(c) Related to siting cooling towers and transmission system upgrades. See Section 8.5.6.3.
(d) Related to Higgins' eye pearlymussel. See Section 8.5.4.4.
(e) Related to potential road and rail construction. See Section 8.6.4.
(f) Beneficial impact with up to a MODERATE impact for Grundy County. See Section 8.5.1.5.
(g) Beneficial impact with up to a MODERATE impact for LaSalle County. See Section 8.5.3.5.
(h) Beneficial impact with up to a MODERATE impact for Ogle County. See Section 8.5.5.5.
(i) See Section 8.5.1.5.
(j) See Section 8.5.2.5.
(k) See Section 8.5.3.5.
(l) See Section 8.5.4.5.
(m) See Section 8.5.5.5.
(n) See Section 8.5.6.5.

Table 8-6. Characterization of Operational Impacts at the Alternative ESP Sites

Category	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Land-Use Impacts						
The site and vicinity	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Transmission-line rights-of-way	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water-Related Impacts						
Water use	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological Impacts						
Terrestrial ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Threatened or endangered species	SMALL to LARGE	SMALL	SMALL	SMALL to MODERATE[a]	SMALL	SMALL
Socioeconomic Impacts						
Physical Impacts						
Workers and local public	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Buildings	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Roads	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aesthetics	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Impacts to the Community - Social and Economic						
Economy	SMALL to MODERATE[b]	SMALL	SMALL to MODERATE[c]	SMALL	SMALL to MODERATE[d]	SMALL
Taxes (beneficial impact)	SMALL to MODERATE[b]	SMALL	SMALL to MODERATE[c]	SMALL	SMALL to MODERATE[d]	SMALL

Table 8-6. (contd)

Category	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Impacts to the Community - Infrastructure and Community						
Transportation	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aesthetics and recreation	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Housing	SMALL to MODERATE[e]	SMALL to MODERATE[f]	SMALL	SMALL	SMALL	SMALL
Public and social services and infrastructure	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Postulated Accidents						
Design-basis accidents	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Severe accidents	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Related to Higgins 'eye pearlymussel. See Section 8.5.4.4.
(b) Beneficial impact with up to a MODERATE impact for Grundy County. See Section 8.5.1.5.
(c) Beneficial impact with up to a MODERATE impact for LaSalle County. See Section 8.5.3.5.
(d) Beneficial impact with up to a MODERATE impact for Ogle County. See Section 8.5.5.5.
(e) Moderate impact for Grundy County. See Section 8.5.1.5.
(f) Moderate impact for Grundy County. See Section 8.5.2.5.

8.8 References

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9.0 Comparison of the Impacts of the Proposed Action and the Alternative Sites

The need to compare the proposed Exelon Generation Company, LLC (Exelon) early site permit (ESP) site with alternative sites arises from the requirement in Section 102(2)(c)(iii), 42 USC 4321(c)(iii) et seq. of the National Environmental Policy Act of 1969 (NEPA) that environmental impact statements include an analysis of alternatives to the proposed action. The U.S. Nuclear Regulatory Commission (NRC) criteria to be employed in assessing whether a proposed ESP site is to be rejected in favor of an alternative site is based on whether the alternative site is "obviously superior" to the site proposed by the applicant (Public Service Co. of New Hampshire 1977). An alternative site is "obviously superior" to the proposed site if it is "clearly and substantially" superior to the proposed site (Rochester Gas & Electric Corp. 1978).

The standard of "obviously superior" "is designed to guarantee that a proposed site will not be rejected in favor of an alternate unless, on the basis of appropriate study, the Commission can be confident that such action is called for" (New England Coalition on Nuclear Pollution 1978). The "obviously superior" test is appropriate for two reasons. First, the analysis performed by the NRC in evaluating alternative ESP sites is necessarily imprecise. Key factors considered in the alternative site analysis, such as population distribution and density, hydrology, air quality, aquatic and terrestrial ecological resources, aesthetics, land use, and socioeconomics are difficult to quantify in common metrics. Given this difficulty, any evaluation of a particular site must necessarily have a wide range of uncertainty. Second, Exelon's proposed ESP site has been analyzed in detail, with the expectation that most adverse environmental impacts associated with the site have been identified. By design the alternative sites have not undergone a comparable level of detailed study. For these reasons, a proposed ESP site may not be rejected in favor of an alternative site when the alternative is "marginally better" than the proposed site, but only when it is "obviously superior" (Rochester Gas & Electric Corp. 1978). NEPA does not require that a nuclear plant be constructed on the single best site for environmental purposes. Rather, "all that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision" (New England Coalition on Nuclear Pollution 1978).

The NRC staff's review of alternative sites consists of a two-part sequential test for "obviously superior" (NRC 2000). The first part of the test determines whether there are "environmentally preferred"[a] sites among the candidate ESP sites. The staff considers whether Exelon has (1) reasonably identified alternative sites, (2) evaluated the likely environmental impacts of construction and operation at these sites, and (3) used a logical means of comparing sites that led to Exelon's selection of the proposed site. Based on the staff's independent review, the staff then determines whether any of the alternative sites are environmentally preferable to Exelon's proposed ESP site.

If the staff determines that one or more alternative ESP sites are environmentally preferable, then it would compare the estimated costs (environmental, economic, and time) of constructing the proposed plant at the proposed site and at the environmentally preferable site or sites (NRC 2000). To find an alternative site obviously superior, the staff must determine that (1) one or more important aspects, either singly or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects of the applicant's proposed site and (2) the alternative site does not have offsetting deficiencies in other important areas. A staff conclusion that an alternative site is obviously superior to Exelon's proposed site would normally lead to a recommendation that the application for the ESP be denied.

9.1 Comparison of the Proposed Site with the Alternative Sites

The staff reviewed the Environmental Report submitted by Exelon (Exelon 2006) and supporting documentation and conducted site visits at the Exelon ESP site and the alternative sites. The staff found that Exelon had reasonably identified alternative sites, evaluated the environmental impacts of construction and operation, and used a logical means of comparing sites. The following section summarizes the staff's independent assessment of the proposed and alternative sites.

The staff's characterization of the expected environmental impacts of constructing and operating a new nuclear unit at the proposed ESP site and alternative sites within the bounds of Exelon's plant parameter envelope are summarized in Tables 9-1 and 9-2. Explanations for the particular characterizations are in Chapters 4 and 5 for the proposed site and in Sections 8.5 and 8.6 for the alternative sites. For those impacts to environmental resources for which the staff was unable to reach a single significance level in Chapters 4 and 5 for the Exelon ESP site due to insufficient information, it is necessary to identify the most likely level of impact for the purposes of comparison to alternative sites. In the following analysis, the staff indicated a likely impact level for these unresolved issues based on professional judgement, experience, and

(a) An "environmentally preferred" alternative site is one for which the environmental impacts are sufficiently less than for the proposed site so that environmental preference for the alternative site can be established (NRC 2000).

consideration of controls likely to be imposed under required Federal, State, or local permits that would not be acquired until an application for a construction permit or combined license is underway. These considerations and assumptions were similarly applied at each of the alternative sites to provide a common basis for comparison. These impact levels are, therefore, best estimates of impacts that the staff used for its "obviously superior" determination. No new data were collected.

Some environmental impacts considered for the Exelon ESP site or for the alternative sites are generic to all sites and, therefore, do not influence the comparison of impacts between the Exelon ESP site and the alternative sites. The generic environmental impacts common to all sites are: air quality, nonradiological and radiological health impacts, environmental impacts from postulated accidents, and historic and cultural resources, as well as some aspects of ecology and socioeconomics.

The environmental impact areas shown in Tables 9-1 and 9-2 have been evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

> 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.

The staff determined the impact level from construction for most of the environmental issues at most of the sites is SMALL (see Table 9-1). For some ecological and socioeconomic issues, there are factors related to a site that could cause the impact level to increase from SMALL to LARGE. These issues and sites are identified in the table by footnotes that briefly describe the factor and location in the EIS for additional information. More detailed information on these issues is presented in Chapter 4 for the Exelon ESP site at Clinton Power Station (CPS) site, and Chapter 8 for the alternative sites. It is the staff's expectation that, if an applicant holding the Exelon ESP chooses to undertake activities permitted by an ESP, it would exercise due diligence to evaluate the potentially adverse impacts and take appropriate measures to mitigate the impacts.

Similarly, the staff determined that the impact level from operations for most of the environmental issues at most of the sites is SMALL (see Table 9-2). Again, there are a few

Table 9-1. Comparison of Construction Impacts at the Exelon ESP Site and Alternative Sites

Impact Category	Clinton	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Land-use							
The site and vicinity	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Transmission line rights-of- way	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water use and quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological							
Terrestrial ecosystems	Unresolved Likely to be SMALL(a)	SMALL to LARGE(b)	SMALL	SMALL	SMALL to LARGE(c)	SMALL	SMALL to LARGE(d)
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Threatened and endangered species	SMALL	SMALL to LARGE(b)	SMALL	SMALL	SMALL to MODERATE(e)	SMALL	SMALL to LARGE(d)
Socioeconomic							
Physical impacts	SMALL to MODERATE(f)	SMALL to MODERATE(g)	SMALL to MODERATE(g)	SMALL to MODERATE(g)	SMALL to MODERATE(g)	SMALL to MODERATE(g)	SMALL to MODERATE(g)
Demography	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Table 9-1. (contd)

Impact Category	Clinton	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Impacts to the Community - Social and Economic (beneficial)	SMALL to MODERATE[h]	SMALL to MODERATE[i]	SMALL	SMALL to MODERATE[j]	SMALL	SMALL to MODERATE[k]	SMALL
Impacts to the Community - Infrastructure and Community	SMALL to MODERATE[l]	SMALL to MODERATE[m]	SMALL to MODERATE[n]	SMALL to MODERATE[o]	SMALL to MODERATE[p]	SMALL to MODERATE[q]	SMALL to LARGE[r]
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Related to transmission system upgrades. See Section 4.4.1.
(b) Related to transmission system upgrades. See Section 8.5.1.3.
(c) Related to transmission system upgrades. See Section 8.5.4.3.
(d) Related to transmission system upgrades. See Section 8.5.6.3.
(e) Related to Higgins' eye pearlymussel. See Section 8.5.4.4.
(f) Related to potential road and rail construction. See Section 4.5.1.
(g) Related to potential road and rail construction. See Section 8.6.4.
(h) Beneficial impact with up to a MODERATE impact for DeWitt County. See Section 4.5.3.
(i) Beneficial impact with up to a MODERATE impact for Grundy County. See Section 8.5.1.5.
(j) Beneficial impact with up to a MODERATE impact for LaSalle County. See Section 8.5.3.5.
(k) Beneficial impact with up to a MODERATE impact for Ogle County. See Section 8.5.5.5.
(l) See Section 4.5.3.
(m) See Section 8.5.1.5.
(n) See Section 8.5.2.5.
(o) See Section 8.5.3.5.
(p) See Section 8.5.4.5.
(q) See Section 8.5.5.5.
(r) See Section 8.5.6.5.

Table 9-2. Characterization of Operational Impacts at the Exelon ESP Site and Alternative Sites

Impact Category	Clinton	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Land-use impacts							
The site and vicinity	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Transmission line rights-of-way	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water-use and quality							
Water use and quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water use in drought years	MODERATE[(a)]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological							
Terrestrial ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aquatic ecosystems	Unresolved, likely to be SMALL[(b)]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Threatened and endangered species	SMALL	SMALL[(b)] to LARGE	SMALL	SMALL	SMALL to MODERATE[(c)]	SMALL	SMALL
Socioeconomic							
Physical	SMALL to MODERATE[(d)]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Table 9-2. (contd)

Category	Clinton	Dresden	Braidwood	LaSalle	Quad Cities	Byron	Zion
Demography	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Impacts to the Community - Social and Economic (beneficial)	SMALL to LARGE[e]	SMALL to MODERATE[f]	SMALL	SMALL to MODERATE[g]	SMALL	SMALL to MODERATE[h]	SMALL
Impacts to the Community - Infrastructure and Community	SMALL to MODERATE[i]	SMALL to MODERATE[j]	SMALL to MODERATE[k]	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL Unresolved for chronic effects of EMF[l]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Postulated accidents	SMALL Unresolved for gas-cooled designs[m]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Temporary MODERATE impact during critical low-water years. See Section 5.3.
(b) Temporary MODERATE impact during critical low-water years. See Section 5.4.2.
(c) Related to Higgins' eye pearlymussel. See Section 8.5.4.4.
(d) Temporary MODERATE impact during critical low-water years. See Section 5.5.1.
(e) Beneficial impact with up to a LARGE impact for DeWitt County. See Section 5.5.3.
(f) Beneficial impact with up to a MODERATE impact for Grundy County. See Section 8.5.1.5.
(g) Beneficial impact with up to a MODERATE impact for LaSalle County. See Section 8.5.3.5.
(h) Beneficial impact with up to a MODERATE impact for Ogle County. See Section 8.5.5.5.
(i) See Section 5.5.3.
(j) See Section 8.5.1.5.
(k) See Section 8.5.2.5.
(l) See Section 5.8.4.
(m) See Section 5.10.

ecological and socioeconomic issues for which the level of significance could rise to MODERATE. These issues and sites are identified in Table 9-2 by footnotes that briefly describe the factor. More detailed information on these issues is presented in Chapter 5 for the Exelon EPS site, and Chapter 8 for the alternative sites.

The socioeconomic impact category reflects only the potential adverse impacts. Positive impacts (that is, tax receipts to local government and public support of the proposed project) would occur but are not addressed here. Significance levels for the positive impacts are given in Chapters 4, 5, and 8.

9.2 Environmentally Preferable Sites

Construction

The impacts of construction at the Exelon ESP site are generally SMALL for all impact categories. However, as noted in Section 4.5, there are two impact areas under Physical and Community Characteristics for which the impacts could rise to the MODERATE level. These areas are the impact of construction traffic on roads and the potential impact of construction workers on housing. The SMALL to MODERATE impact of construction traffic on roads is common to the Exelon ESP site and the alternative sites. The potential MODERATE impact of construction on housing could occur if the construction workers relocated to the CPS area rather than commute from their present residences.

There are SMALL to potentially MODERATE impacts on threatened and endangered species at Quad Cities and SMALL to potentially LARGE impacts at Dresden and Zion. In addition to the SMALL to MODERATE impact of construction traffic on roads at all sites, construction workers would be expected to have potentially MODERATE impacts on transportation at all six of the alternative sites. Mitigation measures would be available to limit the impact.

While there are some differences in the environmental impacts of construction at the Exelon ESP site and the alternative sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the proposed Exelon ESP site.

Operations

The impacts of operations at the Exelon ESP site would be SMALL for all impact categories except for the recreation and housing areas under the Community Characteristics. Under normal water availability, the impact of operation of a new nuclear unit at the Exelon ESP site on recreation would be SMALL. However, in severe drought years, the water use of the unit could cause the level of Clinton Lake to drop enough to limit use of the lake for recreational purposes. In those periods, the impact level would be MODERATE. The residences of the workforce required to operate a nuclear unit at the ESP site are expected to be distributed throughout the area. In this case, the impact on housing would be SMALL. However, should the workforce locate predominately in the smaller towns in the area, the impacts on housing in those towns could be MODERATE.

Most of the impacts of operating a new nuclear unit at the alternative sites would be SMALL. Should a unit be located at either the Dresden or Braidwood sites, there could be MODERATE impacts on housing if the operational workforce located predominantly in Grundy County. These impacts would be similar to the housing impacts that could occur in small towns near the CPS site. For two sites, Dresden and Quad Cities, they could potentially be SMALL to LARGE impacts if there were threatened or endangered species located in the transmission line rights-of-way.

Although there would be some differences in the environmental impacts of operation at the Exelon ESP site and the alternative sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the Exelon ESP site.

9.3 Obviously Superior Sites

None of the alternative sites was determined to be environmentally preferable to the Exelon ESP site. Therefore, none of the alternative sites is obviously superior to the Exelon ESP site.

9.4 Comparison with the No-Action Alternative

The no-action alternative refers to a scenario in which NRC denies the ESP request. If the ESP application for the Exelon ESP site were denied, the impacts of the site preparation activities would not occur. Further, denial of the ESP application would prevent early resolution of safety and environmental issues for the site. These issues would have to be addressed during a future licensing action (ESP, construction permit, or combined license), should an applicant decide to pursue construction and operation activities for a nuclear facility at the site at a later time.

In the event that NRC denies the ESP application, Exelon could follow any of several paths to satisfy its electric power needs: (1) reapplying for an ESP at the Exelon ESP site using a revised plant parameter envelope or a specific reactor design, (2) seeking an ESP, a construction permit, or combined license for a new nuclear unit for a different location, (3) purchasing of power from other electricity providers, (4) establishing conservation and demand-side management programs, (5) constructing new generation facilities other than nuclear at the Exelon ESP site, (6) constructing new generation facilities at other locations, (7) delaying retirement of existing Exelon generating facilities, or (8) reactivating previously retired Exelon generating facilities. The preceding paths could be pursued individually or in combination. Each of the paths would have associated environmental impacts.

The activities that are permissible under an ESP are limited to site preparation activities allowed by 10 CFR 50.10(e)(1). Site preparation activities are permissible only if the final environmental impact statement concludes that the activities would not result in any significant environmental impacts that could not be redressed. The results of the staff's assessment of the site redress plan are discussed in Section 4.11. As discussed in that section, the staff concludes that the potential site-preparation activities described in Exelon's site redress plan would not result in any significant adverse impacts that could not be redressed.

9.5 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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10.0 Conclusions and Recommendations

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Exelon Generation Company, LLC (Exelon) for an early site permit (ESP) for a location identified as the Exelon ESP site, adjacent to the Clinton Power Station, Unit 1. This application has been revised through Revision 4, submitted on April 14, 2006. The site is located in DeWitt County, Illinois, approximately 10 km (6 mi) east of the City of Clinton. An ESP is a Commission approval of a location for the siting of one or more nuclear power facilities, and is a separate action from the filing of an application for a construction permit (CP) or combined construction permit and operating license (combined license or COL) for such a facility. An ESP application may refer to a reactor's or reactors' characteristics or plant parameter envelope (PPE), which is a set of postulated design parameters that bound the characteristics of a reactor or reactors that might be built at a selected site; alternatively, an ESP may refer to a detailed reactor design. The ESP is not a license to build a nuclear power plant; rather, the application for an ESP initiates a process undertaken to assess whether a proposed site is suitable should the applicant decide to pursue a CP or COL.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. Subpart A of Title 10 of the Code of Federal Regulations (CFR) Part 52 contains the NRC regulations related to ESPs. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. As set forth in 10 CFR 52.18, the Commission has determined that an EIS will be prepared during the review of an application for an ESP. The purpose of Exelon's requested action, issuance of the ESP, is for the NRC to determine whether the Exelon ESP site is suitable for a new nuclear unit by resolving certain safety and environmental issues before Exelon incurs the substantial additional time and expense of designing and seeking approval to construct such facilities at the site. Part 52 of Title 10 describes the ESP as a "partial construction permit." An applicant for a CP or COL for a nuclear power plant or plants to be located at the site for which an ESP was issued can reference the ESP, thus reducing the need to review siting issues at that stage of the licensing process. However, issuance of a CP or COL to construct and operate a nuclear power plant is a major Federal action and will require an EIS to be issued in accordance with 10 CFR Part 51.

Three primary issues – site safety, environmental impacts, and emergency planning – must be addressed in the ESP application. Likewise, in its review of the application, the NRC assesses the applicant's proposal in relation to these issues and determines if the application meets the requirements of the Atomic Energy Act of 1954 and the NRC regulations. This EIS addresses the potential environmental impacts resulting from the construction and operation of a new nuclear unit.

In its application, Exelon requested authorization to perform certain site preparation activities after the ESP is issued. The application, therefore, includes a site redress plan that specifies how the applicant would stabilize and restore the site to its preconstruction condition (or conditions consistent with an alternative use) in the event a nuclear power plant is not constructed on the approved site. Pursuant to 10 CFR 52.17(a)(2), the applicant did not address the benefits of the proposed action (e.g., the need for power). In accordance with 10 CFR 52.18, the EIS is focused on the environmental effects of construction and operation of a reactor, or reactors, that have characteristics that fall within the postulated site parameters.

Upon acceptance of the Exelon ESP application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing in the *Federal Register* a Notice of Intent (68 FR 66130) to prepare an EIS and conduct scoping. The staff held a public scoping meeting in Clinton, Illinois on December 18, 2003, and visited the Exelon ESP site in March 2004. Subsequent to the site visit and the scoping meeting and in accordance with NEPA and 10 CFR Part 51, the staff has determined and evaluated the potential environmental impacts of constructing and operating a new nuclear unit at the Exelon ESP site.

Included in this EIS are (1) the results of the NRC staff's preliminary analyses, which consider and weigh the environmental effects of the proposed action (issuance of the ESP) and of constructing and operating a new nuclear unit at the ESP site, (2) mitigation measures for reducing or avoiding adverse effects, (3) the environmental impacts of alternatives to the proposed action, and (4) the staff's recommendation regarding the proposed action based on its environmental review.

During the course of preparing this EIS, the staff reviewed the Environmental Report (ER) submitted by Exelon (Exelon 2006a), consulted with Federal, State, Tribal, and local agencies, and followed the guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits* (NRC 2004), to conduct an independent review of the issues. The review standard draws from the previously published NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 1987), and NUREG-1555, *Environmental Standard Review Plans* (NRC 2000). In addition, the NRC considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this EIS.

The results of this evaluation were documented in a draft EIS issued for public comment in February 2005. During the comment period, the staff conducted a public meeting on April 19, 2005, near the Exelon ESP site to describe the results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft EIS. After the comment period closed, the staff considered and dispositioned all the comments received. These comments are addressed in Appendix E of this EIS.

Following the practice the staff used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) (NRC 1996) and supplemental license renewal EISs, environmental issues are evaluated using the three-level standard of significance – SMALL, MODERATE, or LARGE – developed by NRC using guidelines from the Council on Environmental Quality (40 CFR 1508.27). The footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

> 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.

Mitigation measures were considered for each environmental issue and are discussed in the appropriate sections. During its environmental review, the staff considered planned activities and actions that Exelon indicates it and others would likely take should Exelon decide to apply for a CP or COL. In addition, Exelon provided estimates of the environmental impacts resulting from the construction and operation of a new nuclear unit on the ESP site. Key information considered by the staff in determining the level of impacts to a resource is discussed throughout the report and is listed in Appendix K.

NEPA requires that an EIS include information on:

- Any adverse environmental effects that cannot be avoided should the proposal be implemented
- Any irreversible and irretrievable commitments of resources that would be involved if the proposed action is implemented
- The relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Activities permitted under an ESP that includes a site redress plan include preparation of the site for construction of the facility, installation of temporary construction facilities, excavation for facility structures, construction of service facilities, and construction of certain structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents. These activities are identified in the site redress plan. However, the following discussion of the NEPA requirements addresses the impacts of construction and operation of a new nuclear unit at the Exelon ESP site. The construction impacts bound any impacts of the site preparation activities and preliminary construction activities allowed under 10 CFR 52.25(a).

10.1 Unavoidable Adverse Environmental Impacts

Section 102(2)(C)(ii) of NEPA (42 USC 4321 et seq.) requires that an EIS include information on any adverse environmental effects that cannot be avoided should the proposal be implemented. Unavoidable adverse environmental impacts are those potential impacts of construction and operation of the proposed new units that cannot be avoided and for which no practical means of mitigation are available.

There will be no unavoidable adverse environmental impacts associated with the granting of the ESP with the exception of impacts associated with the limited site-preparation and preliminary construction activities identified in the site redress plan. The impacts associated with the site-preparation and preliminary construction activities are bounded by the construction activities. However, there are unavoidable adverse environmental impacts associated with the construction and operation of a new nuclear unit at the Exelon ESP site.

If granted, the only activities authorized by the ESP would be the following site-preparation activities sought by Exelon, which are described in the volume of the application titled "Administrative Information, Emergency Plan, Site Redress Plan" (Exelon 2006b) and enumerated in 10 CFR 50.10(e)(1):

- Preparation of the site for construction of the facility (including such activities as clearing, grading, and construction of temporary access roads and borrow areas)

- Installation of temporary construction support facilities (including such items as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings)

- Excavation for facility structures

- The construction of service facilities (including such facilities as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, and sanitary sewage treatment facilities)

- The construction of structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents, which could cause undue risk to the health and safety of the public.

If the ESP is granted to Exelon and if Exelon performs any or all of the activities above, but does not, in the future, seek a CP under 10 CFR Part 50 or a COL under 10 CFR Part 52, Exelon would need to redress the site according to the site redress plan included in the application (Exelon 2006b). The staff reviewed the list of allowed site-preparation and preliminary construction activities in the event that the ESP is granted and reviewed the full site redress plan submitted by Exelon. In accordance with 10 CFR 52.17, the application demonstrated that there is reasonable assurance that redress carried out under the plan will achieve an environmentally stable and aesthetically acceptable site suitable for whatever non-nuclear use may conform with local zoning laws. As a result of the staff's independent review, the staff, in accordance with 10 CFR 52.25(a), concludes that the potential site preparation and preliminary construction activities described in Exelon's site redress plan would not result in any significant adverse impacts that could not be redressed.

Unavoidable Adverse Impacts During Construction

Chapter 4 discusses the impacts from construction of a new nuclear unit at the Exelon ESP site in detail. The unavoidable adverse impacts related to construction are listed in Table 10-1 and are summarized below. The primary unavoidable adverse environmental impacts during construction would be related to land use. All construction activities for a new nuclear unit, including ground-disturbing activities, would occur within the existing Clinton Power Station site boundary. According to Exelon, the area that would be affected on a long-term basis as a result of permanent facilities is approximately 39 ha (96 ac). Additional areas would be disturbed on a short-term basis as a result of temporary activities and facilities and laydown areas (Exelon 2006a).

The construction impacts on the terrestrial ecology of the site would be short-term. Construction of a new nuclear unit would result in the removal of approximately 1.45 ha (3.5 ac) of forested habitat within the site. The Exelon ESP site does not contain any old-growth timber, nor any unique or sensitive plants or communities. Therefore, construction activities would not noticeably reduce the local or regional diversity of plants or plant communities. There are no important animal species or habitats on the ESP site. No areas designated by the U.S. Fish and Wildlife Service as critical habitat for endangered or threatened species exist at or near the site, nor are threatened or endangered plants or animals known to exist at the site. Therefore, construction would likely have no impact on any threatened or endangered species, or other important species or habitats. Socioeconomic impacts of construction include an increase in traffic. Atmospheric and meteorological impacts include fugitive dust from construction activities that can be mitigated by the dust control plan. Radiological doses to construction workers from the adjacent unit are expected to be well below regulatory limits. Regarding environmental justice, there are no unusual resource dependencies by minority or low-income populations.

Table 10-1. Unavoidable Adverse Environmental Impacts from Construction

Impact Category	Adverse Impacts Based on Applicant's Proposal	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land use	Yes	Comply with requirements of applicable Federal, State, and Local permits	39 ha (96 ac) disturbed on a long-term basis; additional land disturbed on a temporary basis
Hydrological and water use	Yes	Obtain a 401 Certification prior to site-preparation activities	Dewatering systems would depress the water table in the general vicinity, but the impacts would be localized and temporary
Ecological			
Terrestrial	No	None	None
Aquatic	Yes	Obtain a 401 Certification prior to site-preparation activities	Loss of some benthic macroinvertebrates and shoreline habitat
Socioeconomic	Yes	Increased taxes collected can offset impacts	Increased use of services, traffic congestion
Radiological	Yes	Use of as low as is reasonably achievable (ALARA) principles	Dose to site preparation workers
Atmospheric and meteorological	Yes	Implement actions to reduce fugitive dust	Equipment emissions and fugitive dust from operation of earth-moving equipment are sources of air pollution
Environmental justice	No	Not applicable	Not applicable

Unavoidable Adverse Impacts During Operation

Chapter 5 provides a detailed discussion of the impacts from operation of a new nuclear unit at the Exelon ESP site. The unavoidable adverse impacts related to operation are listed in Table 10-2 and are summarized below. The unavoidable adverse impacts from operation for land use would be small and further mitigation would not be warranted. Hydrological, water use, and water quality impacts during operation would primarily be the result of the operation of the proposed wet cooling tower during periods of reduced water supply in Clinton Lake and downstream assuming a wet cooling tower bounds the consumptive water loss of other cooling systems. In normal water years, the impacts from the cooling system would be SMALL and in low-water years the impacts would be MODERATE. These water impacts are readily mitigated through the State of Illinois authority to regulate water use and water quality. Water impacts would be reversed once the precipitation patterns returned to normal. Aquatic ecology impacts include increased rates of impingement and entrainment of aquatic organisms, based on the cooling water intake design. The proposed new unit is expected to have a cooling-tower-based heat dissipation system, which draws significantly less water than the existing CPS once-through cooling system, thereby resulting in relatively low impingement and entrainment effects. Potential mitigation for cooling water system impacts to aquatic biota would be regulated through the State of Illinois. Socioeconomic impacts would primarily be increased demand for services, with the increase in tax revenue to support the increase in services. It is expected that meteorological impacts would be negligible and that pollutants emitted during operations would be insignificant.

Table 10-2. Unavoidable Adverse Environmental Impacts from Operation

Impact Category	Adverse Impacts Based on Applicant's Proposal	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land use	Yes	Local land management plans	Possible new housing and retail space added in vicinity due to potential growth
Hydrological and water use	Yes	Comply with State permit limits	Decrease in lake level and reduction in available water released from the dam
Ecological			
Terrestrial	No	None	None
Aquatic	Yes	Comply with State permit limits	Increase in impingement/entrainment of aquatic organisms
Socioeconomic	Yes	Increased tax revenues will offset impacts	Increased use of services
Radiological	Yes	Use of as low as is reasonably achievable (ALARA) principles	Dose to workers, the public, and biota
Atmospheric and meteorological	No	None	None
Environmental justice	No	None	None

10.2 Irreversible and Irretrievable Commitments of Resources

Section 102(2)(C)(v) of NEPA (42 USC 4321 et seq.) requires that an EIS include information on any irreversible and irretrievable commitments of resources that would occur if the proposed action is implemented. The only irreversible and irretrievable commitments of resources that would be expended if the proposed action is implemented would be resources used by Exelon for site-preparation activities. If not used during the ESP stage, any such resource commitments for site-preparation activities would be used at the CP or COL stage or could be used for other activities even if Exelon does not eventually seek a CP or a COL for the ESP location.

Irretrievable commitments of resources during construction of the proposed new units generally would be similar to that of any major construction project. The actual commitment of construction resources (concrete, steel, and other building materials) would depend on the reactor design selected at the CP or COL stage. Hazardous materials such as asbestos would not be used, if possible. If materials such as asbestos were used, it would be in accordance with safety regulations and practices. The actual estimate of construction materials would be performed at the CP or COL stage when the reactor design is selected.

The staff expects that the use of construction materials in the quantities associated with those expected for the new ESP unit, while irretrievable, would be of small consequence, with respect to the availability of such resources.

The main resource that would be irretrievably committed during operation of a new nuclear unit would be uranium. The availability of uranium ore and existing stockpiles of highly enriched uranium in the United States and Russia that could be processed into fuel is sufficient, so that the irreversible and irretrievable commitment would be of small consequence.

10.3 Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment

Section 102(2)(C)(iv) of NEPA (42 USC 4321 et seq.) requires that an EIS include information on the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. The only short-term use of the environment that could occur if the proposed action is implemented would be site preparation activities conducted by Exelon that would be authorized in an ESP. Any such activities are unlikely to adversely affect the long-term productivity of the environment. The evaluation of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity for the construction and operation of the ESP unit can only be performed by discussing the benefits of operating the unit. The benefit is the production of electricity. In accordance with 10 CFR 52.18, an EIS for an ESP does not need to include an assessment of the benefits of the proposed action. However, an assessment of the evaluation of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity for the construction and operation of a new nuclear unit would be performed at the CP or COL stage.

10.4 Cumulative Impacts

The staff considered the potential cumulative impacts resulting from construction and operation of the ESP unit with past, present, and reasonably foreseeable future actions in the Exelon ESP site area in Chapter 7 of this EIS. For each impact area, the staff determined that the potential cumulative impacts resulting from construction and operation would be SMALL and that mitigation would not be warranted. Several impact categories have the potential for MODERATE impacts, most of which would occur under temporary circumstances or as the result of a larger-than-expected concentration of construction workers settling near the Exelon ESP site.

10.5 Staff Conclusions and Recommendations

The staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued with the permit condition discussed in Section 4.3.1 of this EIS. The staff's evaluation of the safety and emergency preparedness aspects of the proposed action have been addressed in the staff's final safety evaluation report published May 1, 2006.

This recommendation is based on (1) the ER submitted by Exelon, (2) consultation with Federal, State, Tribal, and local agencies, (3) the staff's independent review, (4) the staff's consideration of comments received from the public, and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its recommendation, the staff has determined that there are no environmentally preferable or obviously superior sites. Finally, the staff has concluded that the site-preparation and preliminary construction activities allowed by (10 CFR 50.10(e)(1)) will not result in any adverse significant impact that cannot be redressed.

A comparative summary showing the environmental impacts of locating a new nuclear unit at the Exelon ESP site and at any of the alternative sites is shown in Table 10-3. Impacts of the no-action alternative, or denial of the ESP application, are also shown. Table 10-3 shows that the significance of the environmental impacts of the proposed action is SMALL for all impact categories with the exception of water use, water quality, ecology, and certain socioeconomic categories. The alternative sites may have environmental effects in at least some categories

Table 10-3. Summary of Environmental Significance of Station Location at the Exelon ESP Site and at Alternative Sites and for the No-Action Alternative

	Proposed Action	No-Action Alternative						
Impact Category	**ESP Site**	**Denial of ESP**	**Dresden**	**Braidwood**	**LaSalle**	**Quad Cities**	**Byron**	**Zion**
Land use	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Water use and quality	SMALL to MODERATE[(a)]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecology	Unresolved, Likely to be SMALL[(b)]	SMALL	SMALL to LARGE[(c)]	SMALL	SMALL	SMALL to LARGE[(d)]	SMALL	SMALL to LARGE[(e)]
Socioeconomics								
Beneficial	SMALL to LARGE[(f)]	SMALL	SMALL to MODERATE[(g)]	SMALL	SMALL to MODERATE[(h)]	SMALL	SMALL to MODERATE[(i)]	SMALL
Adverse	SMALL to MODERATE[(j)]	SMALL	SMALL to MODERATE[(k)]	SMALL to MODERATE[(l)]	SMALL to MODERATE[(m)]	SMALL to MODERATE[(n)]	SMALL to MODERATE[(o)]	SMALL to LARGE[(p)]
Historic and archaeological resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Human health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Temporary MODERATE impact during critical low-water years. See Section 5.3.
(b) See Sections 4.4.1 and 5.4.2.
(c) Related to transmission system upgrades. See Section 8.5.1.3.
(d) Related to Higgins' eye pearlymussel. See Section 8.5.4.4.
(e) Related to transmission system upgrades. See Section 8.5.6.5.
(f) Beneficial impact with up to a LARGE impact for DeWitt County. See Section 5.5.3.
(g) Beneficial impact with up to a MODERATE impact for Grundy County. See Section 8.5.1.5.
(h) Beneficial impact with up to a MODERATE impact for LaSalle County. See Section 8.5.3.5.
(i) Beneficial impact with up to a MODERATE impact for Ogle County. See Section 8.5.5.5.
(j) See Section 5.5.3.
(k) See Sections 8.5.1.5 and 8.6.4.
(l) See Sections 8.5.2.5 and 8.6.4.
(m) See Sections 8.5.3.5 and 8.6.4.
(n) See Sections 8.5.4.5 and 8.6.4.
(o) See Sections 8.5.5.5 and 8.6.4.
(p) See Sections 8.5.6.5 and 8.6.4.

that reach MODERATE to LARGE significance. The staff concludes that none of the alternative sites assessed are obviously superior to the Exelon ESP site.

The range of impacts estimated by the staff was predicated on certain assumptions made by the staff; these are identified in each section and summarized in Appendix K. If the Commission issues the requested ESP and it is later referenced in a CP or COL application, the staff will verify that the assumptions identified in Appendixes J and K remain applicable. In addition, certain issues are not considered to be resolved because of a lack of information in the environmental report or in responses to the staff's requests for additional information. A CP or COL applicant referencing the Exelon ESP would need to provide the missing information for these issues.

10.6 References

10 CFR Part 50. Code of Federal Regulations, Title 10 *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10 *Energy*, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

40 CFR 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Council on Environmental Quality."

68 FR 66130. "Exelon Generation Company, LLC, Clinton Early Site Permit; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*. Vol. 68, No. 227. November 25, 2003.

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Same as above.

10. SUPPLEMENTARY NOTES

Docket No. 52-007

11. ABSTRACT *(200 words or less)*

This report has been prepared in response to an application submitted to the NRC by Exelon Generation Company, LLC, for an early site permit (ESP) for the Exelon ESP site located adjacent to the Clinton Power Station in Clinton, Illinois. The ESP does not authorize construction and operation of a nuclear power plant. However, the application does include a site redress plan that, if approved, would allow limited site preparation work.

The staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued. This recommendation is based on (1) the application, including the Environmental Report (ER), submitted by Exelon; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and this EIS. In addition, in making its recommendation, the staff determined that there are no environmentally preferable or obviously superior sites. Finally, the staff has concluded that the site-preparation and construction activities allowed by 10 CFR 50.10(e)(1) requested by Exelon in its application would not result in any significant adverse environmental impact that cannot be redressed.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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