U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1437
Supplement 42

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 42

Regarding Duane Arnold Energy Center

Draft Report for Comment

Office of Nuclear Reactor Regulation

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Generic Environmental Impact Statement for License Renewal of Nuclear Plants

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Draft Report for Comment

Manuscript Completed: January 2010
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Office of Nuclear Reactor Regulation

Proposed Action	Issuance of a renewed operating license, DPR-49, for Duane Arnold Energy Center (DAEC), in Linn County, Iowa, near the town of Palo.
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Charles Eccleston U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, D.C. 20555-0001 Phone: 301-415-8537 Email: Charles.Eccleston@nrc.gov
Comments	Any interested party may submit comments on this supplemental environmental impact statement. Please specify NUREG-1437, Supplement 42, draft, in your comments. Comments must be received by April 19, 2010. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments will not be given. Comments may be emailed to DuaneArnoldEIS@nrc.gov or mailed to: Chief; Rulemaking and Directives Branch Division of Administrative Services Mailstop TWB-5B01M U.S. Nuclear Regulatory Commission

ABSTRACT

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by FPL Energy Duane Arnold, LLC (FPL-DA) to renew the operating license for Duane Arnold Energy Center (DAEC) for an additional 20 years.

This draft supplemental environmental impact statement provides a preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired generation or natural gas combined-cycle generation plant; this is followed by a combination of alternatives that includes some energy conservation/energy efficiency measures, natural gas-fired capacity, and a wind power component. The analysis also evaluates the environmental effects that could occur if the U.S. Nuclear Regulatory Commission (NRC) takes no action to issue a renewed license for DAEC (No-Action alternative). Section 8.4 explains why the staff dismissed many other alternatives from in-depth consideration.

The preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for DAEC are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable.

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BACKGROUND

By a letter dated September 30, 2008, FPL Energy Duane Arnold, LLC (FPL-DA) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Duane Arnold Energy Center (DAEC) for an additional 20-year period.

The following document and the review it encompasses are requirements of NRC regulations implementing Section 102 of the National Environmental Policy Act (NEPA) of 1969, of the *United States Code* (42 U.S.C. 4321), in Title 10 of the *Code of Federal Regulations* (CFR), Part 51 (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission indicates that issuing a renewed power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to the *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plant*s, NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).

Upon acceptance of the FPL-DA application, the NRC staff began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare an EIS and conduct a public scoping process. The NRC staff held public scoping meetings on April 22, 2009, in Hiawatha, Iowa, and conducted a site regulatory audit at the plant in June 2009.

In preparing this supplemental environmental impact statement (SEIS) for the DAEC, the NRC staff performed the following:

- Reviewed FPL-DA's environmental report (ER) and compared it to the GEIS

- Consulted with other agencies

- Conducted a review of the issues following the guidance set forth in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*

- Considered the public comments received during the scoping process.

PROPOSED ACTION

FPL-DA initiated the proposed Federal action—issuance of a renewed power reactor operating license—by submitting an application for license renewal of DAEC, for which the existing license (DPR-49) expires on February 21, 2014. NRC's Federal action is the decision of whether or not to renew the license for an additional 20 years.

PURPOSE AND NEED FOR ACTION

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 (AEA) or findings in the NEPA environmental analysis that would lead the NRC to not grant a license renewal, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, State regulatory agencies and FPL-DA will ultimately decide whether or not the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, February 21, 2014.

ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

The SEIS evaluates the potential environmental impacts of the proposed action. The environmental impacts of the proposed action can be assigned values of SMALL, MODERATE, or LARGE. The NRC staff established a process for identifying and evaluating the significance of any new and significant information on the environmental impacts of license renewal of DAEC. The NRC did not identify information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process nor the NRC staff's review has identified any new issue applicable to DAEC that has a significant environmental impact. The NRC staff, therefore, relies upon the conclusions of the GEIS for all the Category 1 issues applicable to DAEC.

LAND USE

SMALL. The NRC staff did not identify any Category 2 impact issues for land use, nor did the staff identify any new and significant information during the environmental review; therefore, there would be no impacts beyond those discussed in the GEIS.

AIR QUALITY

SMALL. The NRC staff did not identify any Category 2 issues for the impact of transmission lines on air quality, nor did the staff identify any new or significant information during the environmental review; therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS.

GROUNDWATER USE AND QUALITY

SMALL. Groundwater use conflicts: potable and service water—plants using greater than 100 gallons per minute (gpm) and plants using cooling towers withdrawing makeup water from a small river—are Category 2 issues related to license renewal at DAEC. Information provided by FPL-DA, including groundwater level monitoring data and aquifer test data, shows that DAEC groundwater withdrawal has no significant effect on nearby groundwater wells and ground water supplies.

SURFACE WATER USE AND QUALITY

SMALL to MODERATE. Water use conflicts—plants with cooling ponds or cooling towers using makeup water from a small river with low flow—are a Category 2 issue related to license renewal at DAEC. Withdrawals of Cedar River water by DAEC are approximately 0.6 percent of the average annual flow of the river. The impact is generally SMALL. During low-flow periods, however, the impact may be MODERATE, as the withdrawal rate and consumptive rate are higher proportions of the river flow. By permit, when river flow falls below 500 cubic feet per second (cfs), an upstream reservoir may discharge to the river at a rate equal to the consumptive use rate. At this low-flow threshold, flow in the river is only 13 percent of the average flow, the withdrawal rate is 5 percent of the low flow, and the return of blowdown to the river results in a net consumptive rate of over 3 percent of the low flow.

AQUATIC RESOURCES

SMALL. With regard to operation of DAEC during the license renewal term, the NRC did not identify any Category 2 issues for aquatic resources, nor did the staff identify any new and significant information during the environmental review; therefore, there are no impacts beyond those discussed in the GEIS.

TERRESTRIAL RESOURCES

SMALL. With regard to operation of DAEC during the license renewal term, the NRC did not identify any Category 2 issues for terrestrial resources, nor did the staff identify any new or significant information during the environmental review; therefore, there are no impacts beyond those discussed in the GEIS.

THREATENED AND ENDANGERED SPECIES

SMALL. Impacts to threatened and endangered species during the period of extended operation are Category 2 issues. No Federally listed threatened or endangered terrestrial species are known to occur on the DAEC site or within the in-scope transmission line right of ways (ROWs). Nor are any threatened or endangered aquatic species known to occur within the Cedar River near the vicinity of DAEC or within any streams crossed by in-scope transmission line ROWs. The NRC staff did not identify any new or significant information during the environmental review; therefore, there are no impacts beyond those discussed in the GEIS.

HUMAN HEALTH

SMALL. With regard to Category 1 human health issues during the license renewal term—microbiological organisms (occupational health), noise, radiation exposures to public, occupational radiation exposures, and electromagnetic fields (chronic effects)—the NRC staff did not identify any new or significant information during the environmental review. Therefore, there are no impacts beyond those discussed in the GEIS. The chronic effects of electromagnetic fields from power lines were not designated as Category 1 or 2 issues, and will not be until a scientific consensus is reached on the health implications of these fields. Microbiological organisms (public health) and electromagnetic fields–acute effects (electric shock) are Category 2 human health issues which are discussed below.

The NRC staff considers the GEIS finding of “uncertain” for electromagnetic fields–chronic effects still appropriate and will continue to follow developments on this issue.

The applicant has no plans to conduct refurbishment activities during the license renewal term, thus, no change to radiological conditions is expected to occur. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents are not expected to change during the license renewal term.

The NRC staff concludes that thermophilic microbiological organisms are not likely to present a public health hazard as a result of DAEC discharges to the Cedar River. The NRC staff concludes that impacts on public health from thermophilic microbiological organisms from continued operation of DAEC in the license renewal period would be SMALL.

NRC staff reviewed FPL-DA's analysis of electromagnetic fields–acute shock resulting from induced charges in metallic structures, and verified that there are no locations under the transmission lines that have the capacity to induce more than 5 milliamps (mA) in a vehicle parked beneath the line. No induced shock hazard to the public should occur, since the lines are operating within original design specifications and meet current National Electric Safety Code (NESC) clearance standards. The NRC staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the staff concludes that the potential impacts from electric shock during the renewal period would be SMALL. The NRC staff did not identify any cost benefit studies applicable to the mitigation measures.

SOCIOECONOMICS

SMALL to MODERATE. The NRC staff identified no Category 1 public services and aesthetic impacts, or new and significant information during the environmental review; therefore, there would be no impacts beyond those discussed in the GEIS. Category 2 socioeconomic impacts include housing impacts, public services (public utilities), offsite land use, public services (public transportation), and historic and archaeological resources. Since FPL-DA has indicated that they have no plans to add non-outage employees during the license renewal period, there would be no impact on housing during the license renewal term beyond what has already been experienced. DAEC operations during the license renewal term would also not increase plant-related population growth demand for public water and sewer services. Since there are no planned refurbishment activities at DAEC, there would be no land use impacts related to population or tax revenues, and no transportation impacts.

Based on the NRC staff's review of past surveys conducted at DAEC, review of the procedures for considering historic and archaeological materials at DAEC, and review of the Iowa Historical Society and Iowa State Archaeologist files for the region, the NRC staff concludes that the potential impacts on historic and archaeological resources at DAEC could be MODERATE. However, if DAEC develops procedures that more effectively consider historic and archaeological resources and develops a cultural resource management plan, potential impacts could be minimized or avoided.

With respect to environmental justice, an analysis of minority and low-income populations residing within a 50-mile (80-km) radius of DAEC indicated there would be no disproportionately high and adverse impacts to these populations from the continued operation of DAEC during the license renewal period. As a result of recent monitoring results, concentrations of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals in areas surrounding DAEC have been quite low (at or near the threshold of detection) and seldom above background levels. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

SEVERE ACCIDENT MITIGATION ALTERNATIVES

Since DAEC had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon but potentially serious accidents, NRC regulation 10 CFR 51.53(c)(3)(ii)(L) requires that DAEC evaluate Severe Accident Mitigation Alternatives (SAMAs) in the course of license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon but potentially severe accidents, and may include changes to plant components, systems, procedures, and training.

Based on the review of potential SAMAs, the staff concludes that DAEC made a reasonable, comprehensive effort to identify and evaluate SAMAs. Based on the review of the SAMAs for DAEC, and the plant improvements already made, the staff concludes that none of the potentially cost-beneficial SAMAs that relate to adequately managing the effects of aging are warranted during the period of extended operation; therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

ALTERNATIVES

The NRC staff considered the environmental impacts associated with alternatives to license renewal. These alternatives include other methods of power generation and not renewing the DAEC operating license (the No-Action alternative). Replacement power options considered were supercritical coal-fired generation, natural gas combined-cycle generation, and as part of the combination alternative, construction of wind turbines and a component of energy conservation/energy efficiency. Potential environmental impacts of these alternatives were considered at both the DAEC site and at some other unspecified alternate location for the wind power component of the combination alternative. Each alternative was evaluated using the same impact areas that were used in evaluating impacts from license renewal. The results of this evaluation are summarized in the table on the following page.

COMPARISON OF ALTERNATIVES

A comparison of the impacts of DAEC license renewal with its three reasonable alternatives is provided in Table I-1. In the staff’s best professional opinion, the coal-fired alternative is the least environmentally favorable alternative, due to: impacts to air quality from nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), carbon monoxide (CO), carbon dioxide (CO_2), and mercury—and the corresponding human health impacts. Construction impacts to aquatic, terrestrial, and potentially historic and archaeological resources are also factors that added to this conclusion. The gas-fired alternative would have lower air emissions, but construction-related impacts to aquatic, terrestrial, and historic and archaeological resources would be similar to the coal-fired alternative. The wind power component of the combination alternative would have relatively lower air emissions over its life-cycle, but construction, aesthetic, and land use impacts would likely be substantial larger because of the amount of land required.

The NRC notes that the renewal of the DAEC license could have a MODERATE impact on two environmentally-related issues, and SMALL impacts on all other categories evaluated; therefore, in the staff’s professional opinion, renewal of the DAEC license is the environmentally preferred action. All other alternatives capable of meeting the needs currently served by DAEC entail potentially greater impacts than the proposed action involving license renewal of DAEC. The No-Action alternative does not meet the purpose and need of this draft SEIS.

Table I-1. Comparison of the Impacts of the DAEC License Renewal and its Three Reasonable Alternatives

Alternative	Land Use	Air Quality	Groundwater	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socioeconomics	Waste Management
	Impact Area							
DAEC License Renewal	S to M	S	S	S to M	S	S	S to M	S[b]
Supercritical Coal-Fired Alternative at DAEC Site	M	M	S	S	S to M	S	S to M	M
Natural Gas Combined-Cycle Alternative at DAEC site	S to M	S to M	S	S	S	S	S to M	S
Combination Alternative 1[a]	S to M	S	S	S	S to M	S	S to M	S
No-Action Alternative	S	S	S	S	S	S	S to M	S

[a] Combination alternative consists of gas-fired generation, wind power, and conservation

[b] For the DAEC license renewal alternative, waste management was evaluated in Chapter 6. Consistent with the findings in the generic environmental impact statement (GEIS), these impacts were determined to be SMALL with the exception of collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

S – SMALL impact
M – MODERATE impact
L – LARGE impact

RECOMMENDATION

Our preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for DAEC are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on:

(1) The analysis and findings in the GEIS

(2) Information submitted in the FPL-DA's ER

(3) Consultation with other Federal, State, and local agencies

(4) A review of other pertinent studies and reports

(5) A consideration of public comments received during the scoping process.

REFERENCES

U.S. Nuclear Regulatory Commission (NRC). *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C., 1996. ADAMS Accession Nos. ML040690705 and ML040690738.

U.S. Nuclear Regulatory Commission (NRC). *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C., 1999.

ABBREVIATIONS AND ACRONYMS

ac	acre
AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
AQCR	Northeast Iowa Intrastate Air Quality Control Region
BWR	boiling water reactor
cfs	cubic feet per second
cm	centimeter
CAA	Clean Air Act
CDC	Center for Disease Control
CDF	core damage frequency
CEQ	Council on Environmental Quality
CESQG	conditionally exempt small quantity generators
CFR	Code of Federal Regulations
CFS	cubic feet per second
CO	carbon monoxide
COPC	chemicals of potential concern
CRT	cathode ray tube
CWA	Clean Water Act
DAEC	Duane Arnold Energy Center
DBA	design-basis accident
DOE	Department of Energy
DPR	demonstration power reactor
DSEIS	draft supplemental environmental impact statement
DSM	demand-side management
EIA	Energy Information Administration (of DOE)
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field

EMF	electromagnetic force
EMS	environmental management system
EOP	emergency operating procedure
ER	environmental report
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act of 1973
ESW	emergency service water
ft/s	feet per second
ft^3/s	cubic ft per second
$ft^3/year$	cubic ft per year
FES	final environmental statement
FPL	Florida Power and Light
FPL-DA	Florida Power and Light Energy Duane Arnold, LLC
FSAR	final safety analysis report
ft	feet
GEIS	generic environmental impact statement
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute
ha	hectare
HAP	hazardous air pollutants
HLW	high-level waste
HVAC	heating, ventilation, and air conditioning
Hz	hertz
in	inch
IAC	Iowa Administrative Code
IBI	Index of Biotic Integrity
ICCAC	Iowa Climate Change Advisory Council (ICCAC)
IDNR	Iowa Department of Natural Resources

Inc.	incorporated
IPA	integrated plant assessment
ISFSI	independent spent fuel storage installation
ISO	International Standardization Organization
ITC	Information Technology Midwest LLC
km	kilometers
km^2	kilometers squared
Kv	kilovolts
LCCO	Linn County Code of Ordinances
LCPH	Linn County Public Health Department
LLC	limited liability corporation
LLMW	low-level mixed waste
LLW	low–level radioactive waste
LOCA	loss of coolant accident
LOS	level of service
LQG	large quantity generators
LWR	light-water reactor
m	meter
mA	milliamps
mi	miles
mGy	milligray
mi^2	miles squared
m^3/s	cubic meters per second
m/s	meters per second
mrad	millirad
mrem	millirem
MRS	Midcontinent Rift System
MSL	mean sea level
mSv	millisievert
MTU	metric ton uranium

MW	megawatt
MWe	megawatt-electric
MWt	megawatt-thermal
ug/m^3	micrograms per cubic meter
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NOx	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NUREG	NRC Regulatory Guide
NWS	National Weather Service
PCB	polychlorinated biphenol
pCi/L	picocuries per liter
PDS	plant damage state
PM	particulate matter
$PM_{2.5}$	particulate matter, 2.5 microns or less in diameter
PM_{10}	particulate matter, 10 microns or less in diameter
POE	potential to emit
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
Psig	pound-force per square inch gauge
R-12	dichlorodifluoromethane
R-22	chlorodifluoromethane
RBCCW	reactor building closed cooling water
RCRA	Resource Conservation and Recovery Act

REMP	radiological environmental monitoring program
RHRSW	residual heat removal service water
ROI	region of influence
ROW(s)	right of way(s)
SAMA	Severe Accident Mitigation Alternative
SAR	safety analysis report
SER	safety evaluation report
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SQG	small quantity generators
STF	stormwater and sewage treatment facility (STF)
SPDS	safety parameter display system
TLD	thermoluminescent dosimeters
TSC	technical support center
TSS	total suspended solids
U	Uranium
UFSAR	updated final safety analysis report
USFWS	U.S. Fish and Wildlife Service
U.S.	United States
USGS	U.S. Geological Survey
USGCRP	*United States Global Change Research Program*

1.0 PURPOSE AND NEED FOR ACTION

Pursuant to the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, of the U.S. *Code of Federal Regulations* (10 CFR 51), which implement the U.S. National Environmental Policy Act of 1969 (NEPA), an environmental impact statement (EIS) is required to be prepared for issuance of a new nuclear power plant operating license.

The Atomic Energy Act of 1954 (AEA) originally specified that licenses for commercial power reactors be granted for up to 40 years with an option to renew for up to another 20 years. The 40-year licensing period is based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal rests entirely with nuclear power facility owners and typically is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC staff (Staff) makes the decision to grant or deny a license renewal, based on whether or not the applicant has demonstrated that the environmental and safety requirements in the NRC's regulations can be met during the period of extended operation.

1.1 PROPOSED FEDERAL ACTION

FPL Energy Duane Arnold, LLC (FPL-DA) initiated the proposed Federal action by submitting an application for license renewal of Duane Arnold Energy Center (DAEC), for which the existing license number DPR-49 currently expires on February 21, 2014. NRC's Federal action is the decision of whether or not to renew the license for an additional 20 years.

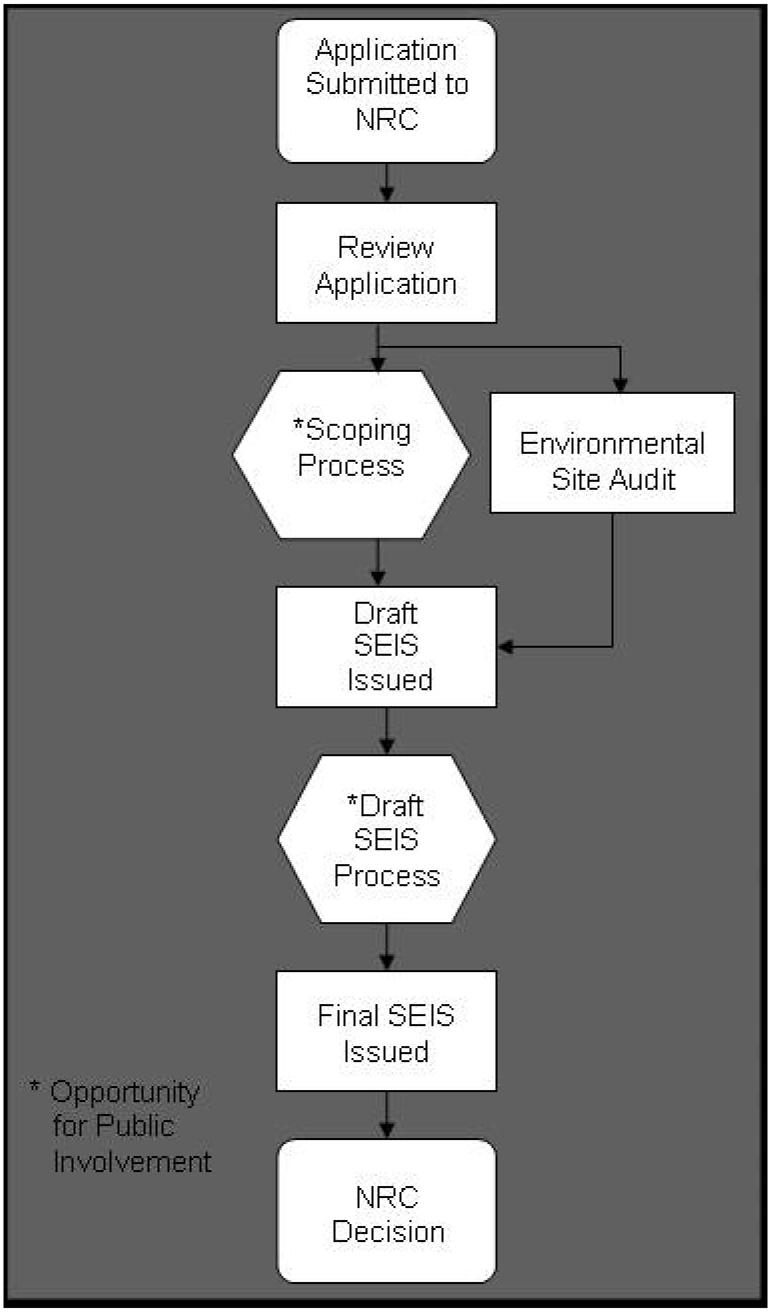
1.2 PURPOSE AND NEED FOR THE PROPOSED FEDERAL ACTION

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, which may be determined by State, utility, and, where authorized, Federal (other than NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the AEA or findings in the NEPA environmental analysis that would lead the NRC to not grant a license renewal, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether or not a particular nuclear power plant should continue to operate.

If the renewed license is issued, State regulatory agencies and FPL-DA will ultimately decide whether the plant will continue to operate or not based on factors such as the need for power, or other matters within the State's jurisdiction, or the purview of the owners. If the operating license is not renewed, the facility must be shut down on or before the expiration date (February 21, 2014) of the current operating license.

1.3 MAJOR ENVIRONMENTAL REVIEW MILESTONES

Figure 1-1. Environmental Review Process. *The environmental review provides opportunities for public involvement.*



As part of its license renewal application, DAEC submitted an environmental report (ER) dated September 30, 2008 (FPL-DA, 2008). After reviewing the application and the ER for sufficiency, the Staff published a notice of acceptance for docketing of the application on February 17, 2009, in the *Federal Register* (FR) (73 FR 7489). On March 24, 2009, the NRC published another notice in the FR (74 FR 12399) on its intent to conduct scoping, thereby beginning a 60-day public scoping period for the supplemental environmental impact statement (SEIS).

> ***Significance*** indicates the importance of likely environmental impacts and is determined by considering two variables: ***context*** and ***intensity***.
> ***Context*** is the geographic, biophysical, and social context in which the effects will occur.
> ***Intensity*** refers to the severity of the impact, in whatever context it occurs.

NRC conducted two public scoping meetings on April 22, 2009, in Hiawatha, IA. The Staff prepared an SEIS scoping process summary report dated August 7, 2009, which presents the comments received during the scoping process (NRC, 2009a). Appendix A to this SEIS presents comments considered to be within the scope of the environmental license renewal review and the associated NRC responses.

To independently verify information provided in the ER, the Staff conducted a site audit at the DAEC site in June of 2009. During the site audit, the Staff met with plant personnel, reviewed specific documentation, toured the facility, and met with interested Federal, State, and local agencies. A summary of that site audit and the attendees is contained in the site audit summary report (NRC, 2009b).

On completion of the scoping period and site audit, the Staff compiled its findings in this draft SEIS (Figure 1-1). This SEIS is being made publicly available for a period of 75 days during which the Staff will host public meetings and collect public comments. Based on the information gathered, the Staff will amend the draft SEIS findings as necessary, and then publish the final SEIS.

The Staff has established a license renewal process that can be completed in a reasonable period of time with clear requirements to assure safe plant operation for up to an additional 20 years. The safety review, which documents its finding in a safety evaluation report (SER), is conducted simultaneously with the environmental review process. Both the findings in the SEIS and the SER are factors considered in the Commission's decision to either grant or deny the issuance of a new license.

1.4 GENERIC ENVIRONMENTAL IMPACT STATEMENT

To improve the efficiency of the license renewal process, the Staff prepared a generic assessment of the environmental impacts associated with license renewal. Specifically, the agency prepared NUREG-1437, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Power Plants*, which evaluates the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years (NRC 1996, 1999).[1] The Staff analyzed those environmental issues that could be resolved generically in the GEIS.

The GEIS investigates 92 separate issues for Staff to consider. Of these, the Staff determined that 69 are generic to all plants (Category 1), while 21 issues do not lend themselves to generic consideration (Category 2). Two other issues remain uncategorized; environmental justice and the chronic effects of electromagnetic fields, which must be evaluated on a site-specific basis. Appendix B of this report lists all 92 issues.

[1] The NRC originally issued the GEIS in 1996 and issued Addendum 1 to the GEIS in 1999. Hereafter, all references to the GEIS include the GEIS and Addendum 1.

For each environmental issue, the GEIS: (1) describes the activity that affects the environment; (2) identifies the population or resource that is affected; (3) assesses the nature and magnitude of the impact on the affected population or resource; (4) characterizes the significance of the effect for both beneficial and adverse effects; (5) determines whether the results of the analysis apply to all plants or not; and (6) considers whether additional mitigation measures are warranted or not for impacts that would have the same significance level for all plants.

The GEIS assesses the significance of these issues, using the Council on Environmental Quality (CEQ) terminology for "significant." The Staff established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE. The three levels of significance are defined below:

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 destabilize, important attributes of the resource.

LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The GEIS includes a determination of whether or not the analysis of the environmental issue could be applied to all plants and whether or not additional mitigation measures are warranted (Figure 1-2). Issues are assigned as a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

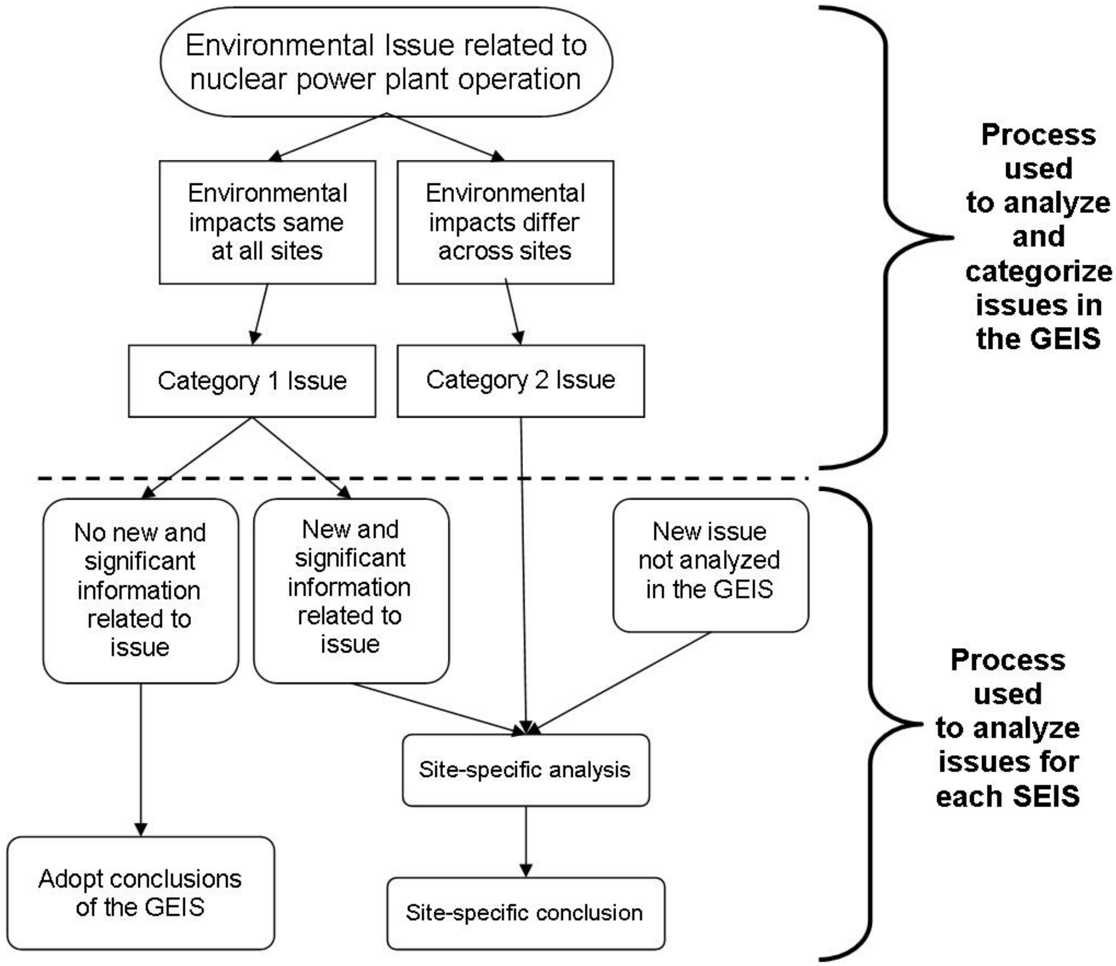
(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts, except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), no additional site-specific analysis is required in this SEIS unless new and significant information is identified. Chapter 4 of this report presents the process for identifying new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criterion for Category 1 issues, and therefore, additional site-specific review for these issues is required. The SEIS documents the results of that site-specific review.

Figure 1-2. Environmental Issues Evaluated during License Renewal. *Ninety-two issues were initially evaluated in the GEIS. A site-specific analysis is required for 23 of those 92 issues.*



1.5 SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

This SEIS presents an analysis of the environmental effects of the continued operation of the DAEC, potential alternatives to license renewal, and potential mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains analyses and comparisons of environmental impacts from alternatives. Chapter 9 presents the preliminary recommendation to the Commission as to whether or not the environmental impact of license renewal are so great that preserving the option of license renewal would be unreasonable. The recommendation will be made after consideration of comments received during the public scoping period and the public comment period for the draft SEIS.

In preparation of this SEIS, the Staff:

- reviewed the information provided in the FPL-DA ER
- consulted with other Federal, State, and local agencies
- conducted an independent review of the issues during site audit
- considered the public comments received during the scoping process and on the draft SEIS.

New and significant information can be identified from a number of sources, including the Staff, the applicant, other agencies, and public comments. If a new issue is revealed, it is first analyzed to determine whether or not it is within the scope of the license renewal evaluation. If it is not addressed in the GEIS, then the NRC determines its significance and documents its analysis in the SEIS.

> **New and significant information either**:
> (1) identifies a significant environmental issue not covered in the GEIS, or
> (2) was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

1.6 COOPERATING AGENCIES

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this SEIS.

1.7 CONSULTATIONS

The Endangered Species Act of 1973, as amended; the Magnuson-Stevens Fisheries Conservation and Management Act of 1996, as amended; and the National Historic Preservation Act of 1966, require that Federal agencies consult with applicable State and Federal agencies and groups before taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively.

Listed below are the agencies and groups with whom the NRC consulted; Appendix D of this report includes copies of consultation documents.

- Iowa Department of Natural Resources
- Region 3, U.S. Fish and Wildlife Service
- Iowa State Archaeologist, Office of the State Archaeologist
- Historic Preservation Officer, State Historical Society of Iowa

1.8 CORRESPONDENCE

Table 1-1 lists persons and organizations to which a copy of this draft SEIS is sent. Appendix E to this report contains a chronological list of all documents sent and received during the environmental review. During the course of the environmental review, the Staff corresponded or consulted with the following Federal, State, regional, local, or tribal agencies:

Advisory Council on Historic Preservation

National Oceanographic and Atmospheric Administration, National Marine Fisheries Service

State Archaeologist, Office of the State Archaeologist

Historic Preservation Officer State Historical Society of Iowa

Iowa Department of Natural Resources

Region 3, U.S. Fish and Wildlife Service

Flandreau Santee Sioux Tribe

Ho-Chunk Nation

Iowa Tribe of Oklahoma

Kickapoo Tribe in Kansas

Prairie Band of Potawatomi Indians

Prairie Island Indian Community

Sac and Fox Nation of Missouri

Sac and Fox Nation of Oklahoma

Santee Sioux Nation

Shakopee Mdewakanton Sioux Community of Minnesota

Upper Sioux Community of Minnesota

Winnebago Tribe of Nebraska

The Sac and Fox Tribe of the Mississippi

Lower Sioux Indian Community of Minnesota

Omaha Tribal Council

Kickapoo Tribe of Oklahoma

Otoe-Missouria Tribe of Indians

Iowa Tribe of Kansas and Nebraska

1 **Table 1-1. List of persons who are sent a copy of this draft SEIS**

Mr. M. S. Ross Florida Power & Light Company	Ms. Marjan Mashhadi Florida Power & Light Company	T. O. Jones, VPVice President Florida Power & Light Company
Steven R. Catron, Manager Duane Arnold Energy Center	U.S. Nuclear Regulatory Commission Resident Inspector's Office	Mano Nazar Sr. VP and Nuclear Chief Operating Officer, Florida Power & Light Company
D. A. Curtland Duane Arnold Energy Center	Abdy Khanpour, VP Florida Power & Light Company	Melanie Rasmusson Iowa Department of Public Health
Linn County Board of Supervisors	Peter Wells, Acting VP Florida Power & Light Company	U.S. Environmental Protection Agency
Mark E. Warner, VP Florida Power & Light Company	Fredia Perkins, Chairperson Sac and Fox Nation of Missouri	Christie Modlin, Chairperson, Iowa Tribe of Oklahoma
Steve Cadue, ChairmanKickapoo Tribe in Kansas	Steve Ortiz, Chairman Prairie Band of Potawatomi Indians	Joshua Weston, President, Flandreau Santee Sioux Tribe
Roger Trudell, Chairman Santee Sioux Nation	John Blackhawk Winnebago Tribe of Nebraska	Ronald Johnson Prairie Island Indian Community
Stanley R. Crooks Shakopee Mdewakanton Sioux Community of Minnesota	Kevin Jensvold Upper Sioux Community of Minnesota	Wilfred Cleveland Ho-Chunk Nation
Dusky Terry Central Iowa Power Cooperative	Bennett Brown member of the public	Amir H. Moazzez member of the public
Adrian Pushetonequa The Sac and Fox Tribe of the Mississippi	Lori Nelson Lower Sioux Indian Community of Minnesota	Amen Sheriden Omaha Tribal Council
Marlon E. Frye Kickapoo Tribe of Oklahoma	John Shotton Otoe-Missouria Tribe of Indians	Leon Campbell Iowa Tribe of Kansas and Nebraska
Dr. Roy Crabtree, NOAA National Marine Fisheries Service	Wayne Gieselman, Administrator Iowa Department of Natural Resources	Tom Melius, Regional 3 Director U.S. Fish and Wildlife Service
Charlene Dwin Vaughn Assistant Director Advisory Council on Historic Preservation	John Doershuck State Archaeologist Office of the State Archaeologist	Jerome Thompson Interim State Historic Preservation Officer State Historical Society of Iowa
George Thurman, Principal Chief Sac and Fox Nation of Oklahoma		

2 1.9 STATUS OF COMPLIANCE

3 FPL-DA is responsible for complying with all NRC regulations and other applicable Federal,
4 State, and local requirements; Appendix C describes some of the principle Federal statutes for
5 which FPL-DA must comply. Table 1-2 lists the numerous permits and licenses issued by
6 Federal, State, and local authorities for activities at DAEC.

1 **Table 1-2. Licenses and Permits.** *Existing environmental authorizations for Duane Arnold*
2 *Energy Center Operations.*

Permit/License	Number	Date	Responsible Agency
License to operate DAEC	DPR-49	Issued: 02/21/1974 Expires: 02/21/2014	U.S. Nuclear Regulatory Commission
Hazardous materials shipment registration	070908 550 040QS	Issued: 07/09/2008 Expires: 06/30/2011	U.S. Department of Transportation
Hazardous waste generation/transport	IAD984566133	N/A	U.S. Environmental Protection Agency
Permit for water intake and discharge structures and low head dam on Cedar River	71-192	Issued: 08/06/1971	Iowa Department of Natural Resources (DNR)
Permit to store water in Pleasant Creek Reservoir and withdraw water from Cedar River	3533-R3	Issued: 03/14/2004 Expires:03/13/2014	Iowa DNR
Dredging for constructing spur dikes and subsequent maintenance dredging	05-I-113-08-02-S	Issued: 08/26/2005	Iowa DNR
Dredging for spur dikes and subsequent maintenance dredging	CEMVR-OD-P-2005-1016	Issued: 09/20/2005 Expires: 12/31/2010	U.S. Army Corps of Engineers
Flood Plain Development Permit	PF07-015	Issued: 12/04/2007 Expires: 12/04/2008	Linn County
Sovereign Lands Construction Permit	06-141	Issued: 10/10/2006 Expires: 12/31/2008	Iowa DNR
Sovereign Lands Construction Permit	07-175	Issued: 11/07/2007 Expires: 12/31/2009	Iowa DNR
Drinking water system operation certification	Operator ID# 6007	Issued: 08/29/2007 Expires: 06/30/2009	Iowa DNR
NPDES Permit	57-00-1-04 IA0003727	Issued: 07/06/2007 Expires: 07/05/2009	Iowa DNR
Air Operation Permit	4863, 4864, 4865, 4866, 4867, 4868, 4869, 4870	Expires 11/10/2008	Linn County
Transportation service license	N/A	Issued: 06/25/2007 Expires: 06/30/2009	Iowa Department of Public Health
Permit to operate public water system	ID# IA5715150	Issued: 11/21/2006 Expires: 12/31/2009	Iowa DNR
Permit to operate 4-well system for potable water	3046-MR5 SDWIS Well ID#s: WL04, WL05, W06, WL07	Issued: 07/01/2002 Expires: 06/30/2012	Iowa DNR
Underground storage tanks	N/A	N/A	Iowa DNR
License to ship radioactive material	T-IA-001-L08	Expires: 12/31/2008	Tennessee Department of Environment and Conservation
License to ship radioactive material	0210001768	Expires: 10/27/2008	Utah Department of Environmental Quality

1.10 REFERENCES

Atomic Energy Act of 1954. §42 U.S.C. §2011, et seq.

Endangered Species Act of 1973. §16 U.S.C. §1531, et seq.

Federal Register (FR). U.S. Nuclear Regulatory Commission (NRC) . Washington DC. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DPR-49 for an Additional 20-Year Period for FPL Energy Duane Arnold, LLC Duane Arnold Energy Center," Vol. 74, No. 30, Page 7489-7491. February 17, 2009.

FPL Energy Duane Arnold LLC (FPL-DA). Duane Arnold Energy Center, License Renewal Application, Appendix E – Applicant's Environmental Report – Operating License Renewal Stage, Duane Arnold Energy Center. September 2008.

FR. NRC. Washington DC. "FPL Energy Duane Arnold, LLC; Duane Arnold Energy Center; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process," Vol. 74, No. 55, Page 12399-12401. March 24, 2009.

Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996. §16 U.S.C. §1855, et seq.

National Environmental Policy Act of 1969. §42 United States Code (U.S.C.) §4321, et seq.

National Historic Preservation Act of 1966. §16 U.S.C. §470, et seq.

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

U.S. Nuclear Regulatory Commission (NRC). Generic Environmental Impact Statement for License Renewal of Nuclear Plants. NUREG-1437, Vol. 1 and 2, Washington, DC, 1966. ADAMS Accession Nos. ML040690705 and ML040690738.

NRC. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, "Section 6.3 – Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Vol. 1, Add. 1, Washington, DC, 1999.

NRC, 2009a. Issuance of the Environmental Scoping Summary Report for the Staff's Review of the License Renewal Application for Duane Arnold Energy Center (Tac No. MD9770). August 7, 2009. Adams Accession No. ML092030185.

NRC, 2009b. Summary of Environmental Site Information Review (Site Audit), Related to Review of the License Renewal Application for Duane Arnold Energy Center (Tac No. MD9770). July 2, 2009. Adams Accession No. ML091750075.

2.0 AFFECTED ENVIRONMENT

Duane Arnold Energy Center (DAEC) is located in Linn County, Iowa, on the western bank of a north-south reach of the Cedar River, approximately two miles north-northeast of the town of Palo and approximately three miles east of the Benton County line. Figure 2-1 shows the location of DAEC within a six-mile radius.

Because existing conditions are partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions and how they have shaped the environment are presented in this chapter. Section 2.1 of this report describes the DAEC site, facility, and its operation; Section 2.2 discusses the affected environment; and Section 2.3 describes related Federal and State activities near the DAEC site.

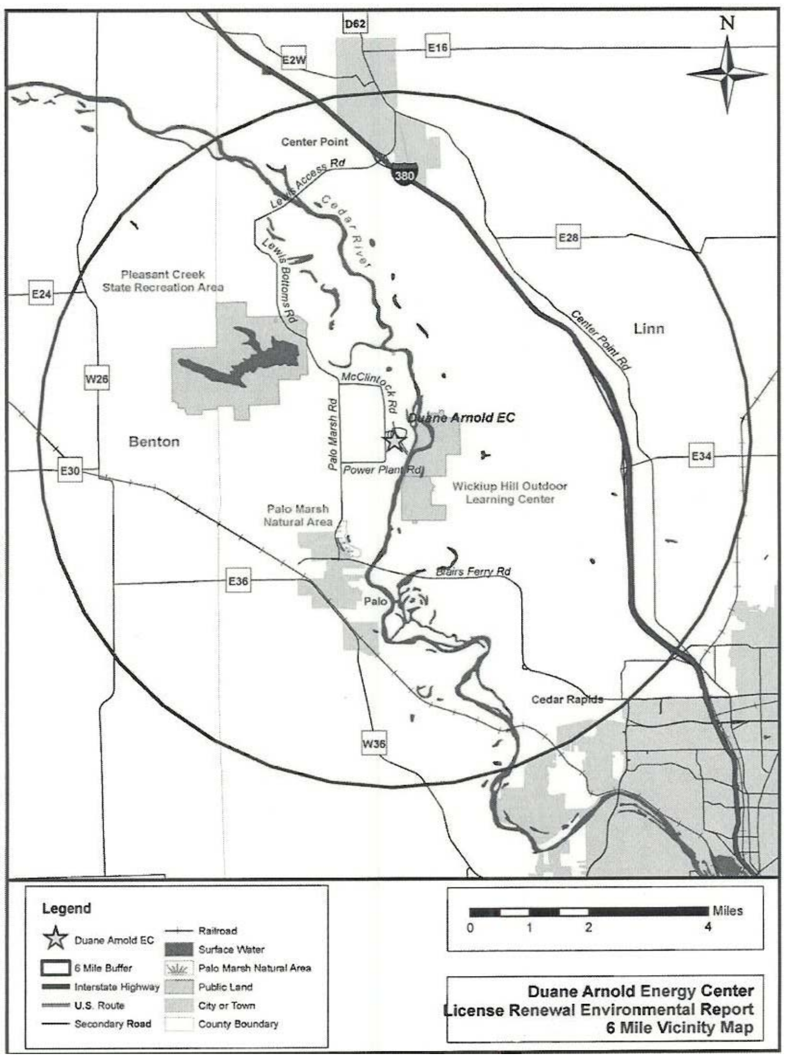


Figure 2-1. Location of Duane Arnold Energy Center, within a 6-Mile Radius (Source: (FPL-DA, 2008a, Figure 2.1-1)

2.1 FACILITY AND SITE DESCRIPTION AND PROPOSED PLANT OPERATION DURING THE RENEWAL TERM

DAEC is located in a rural, sparsely populated area. The site encompasses approximately 500 acres (Figure 2-2 shows an aerial photograph of the plant site, switchyard, and transmission lines). DAEC uses only a small portion of the acreage for power production; the remaining portion is leased to area farmers (FPL Energy Duane Arnold, LLC (FPL-DA), (FPL-DA, 2007a). The site's property boundary and facility layout are shown in Figure 2-3 (FPL-DA, 2005a). The site is located on a strip of land running northeast and parallel to the Cedar River, which is the largest tributary of the Iowa River. The site is a flat plain, approximately 750 feet above mean sea level. The general topographical features in this portion of the Cedar River consist of broad valleys and narrow flood plains. Across the Cedar River from the site, the land rises to an elevation of about 900 feet. The slopes are heavily wooded, but away from the immediate vicinity of the river, the land is gently rolling farmland (FPL-DA, 2005a).

Figure 2-2. Plant Site, Switchyard, and Transmission Lines (Source: FPL-DA, 2008a)

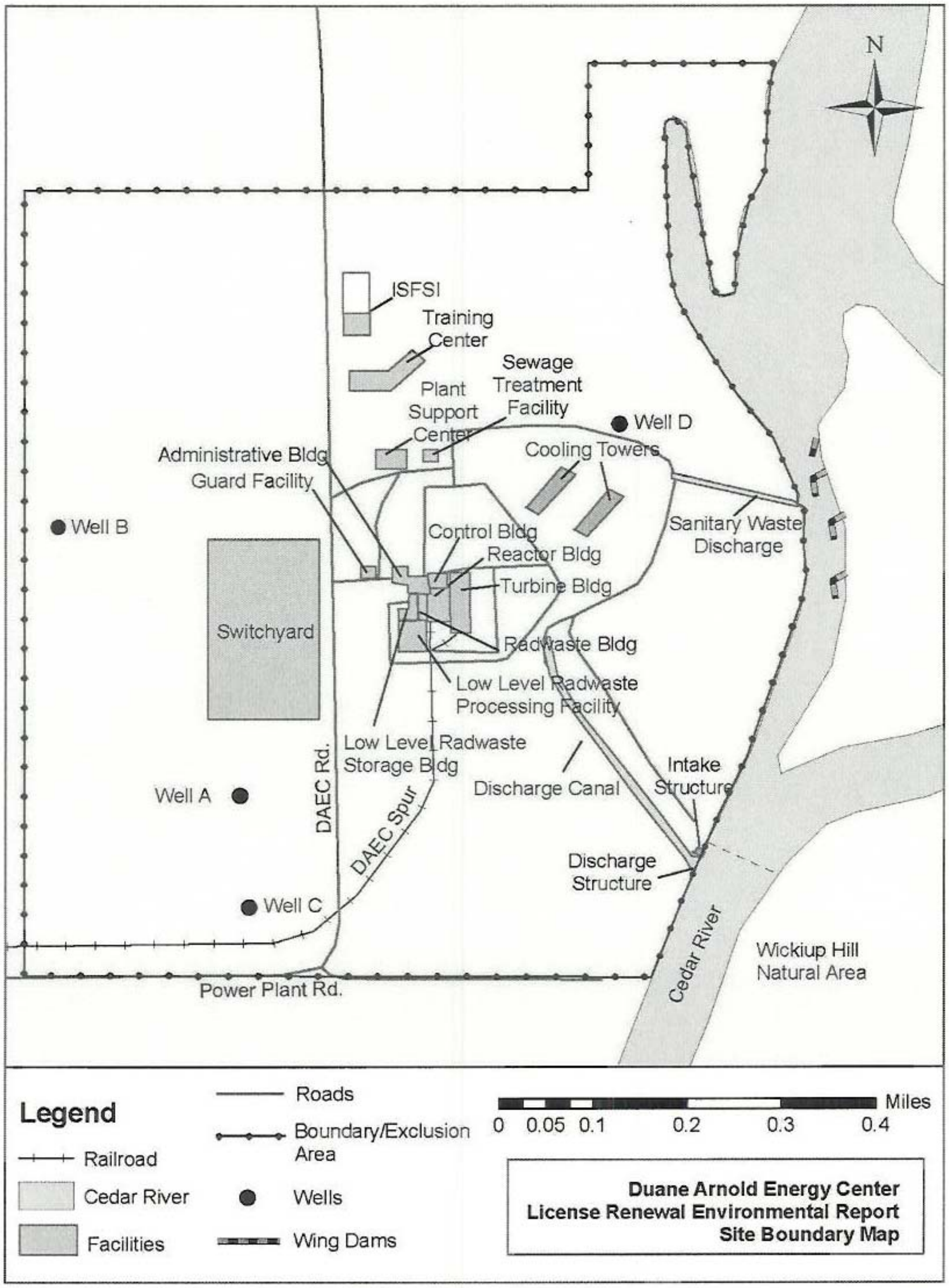


Figure 2-3. Duane Arnold Energy Center Property Boundaries and Facility Layout (Source: FPL-DA 2008a, Figure 2.1-3)

Three metropolitan areas lie within 50 miles of the DAEC site: Waterloo, approximately 34 miles to the northwest; Iowa City, approximately 32 miles to the southeast; and Cedar Rapids, the closest city, approximately 5.7 miles to the southeast (Figure 2-4 shows a map of DAEC within a 50-mile radius). Industrial activities within 10 miles of the site are confined principally to the Cedar Rapids metropolitan area. There is no significant industrial activity near the site. Manufacturing is the single-most important industry to the Linn County economy (USCB, 2005). Smaller communities in the vicinity of the site consist of small retail businesses.

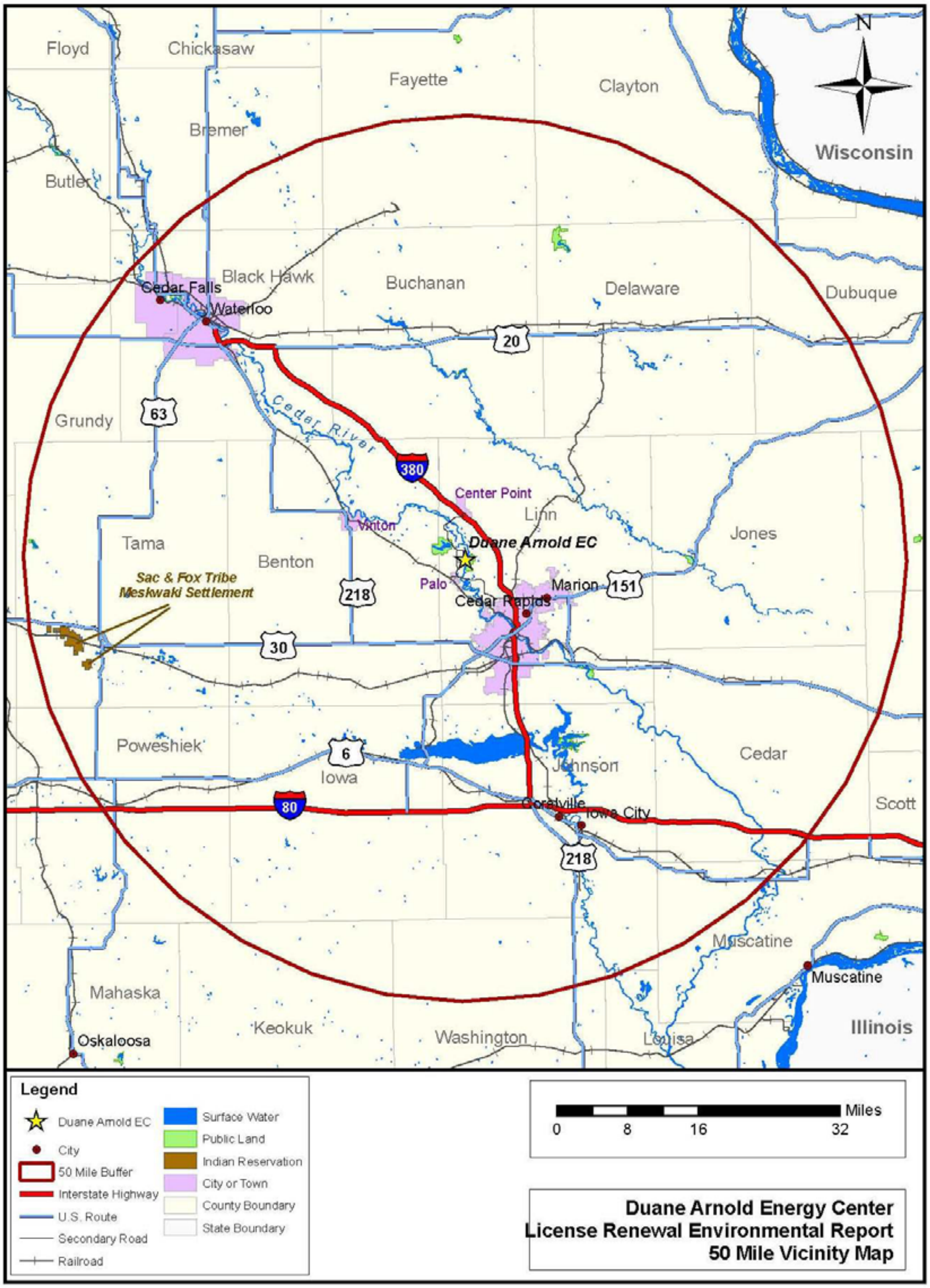


Figure 2-4. Location of Duane Arnold Energy Center, within a 50-Mile Radius (Source: FPL-DA, 2008a)

Located one mile northwest of the site is the Pleasant Creek State Recreation Area, a 1,927-acre park. Included in this acreage is a 410-acre lake that was jointly developed by the Iowa Conservation Commission and the Iowa Electric Light and Power Company to provide a supplemental water supply for DAEC and, at the same time, regional recreation opportunities (IDNR, 2007a).

Recreational activities at several park areas within 10 miles of the site consist of boating, fishing, hunting, camping, hiking, picnicking, and swimming. Palo Marsh Wildlife Refuge, located two miles south of DAEC, is a 144-acre site featuring a wetland trail and bottomland forest for wildlife observation. Wickiup Hill is a 563-acre natural area located across from Cedar River just east of DAEC, which includes the 240-acre Wickiup Hill Outdoor Learning Area and a 10,000-square foot learning center (LCCD, 2007). Cedar Rapids offers many attractions that draw visitors from surrounding areas, including the annual Cedar Rapids Freedom Festival which is typically a 16-day event (Cedar Rapids, 2007).

The DAEC employs more than 600 Iowans and is the only nuclear reactor in the State of Iowa (FPL-DA, 2007a). The nuclear reactor is a single General Electric (GE) boiling water reactor (BWR) of the standard BWR-4 design, with a generating capacity of 610 gross megawatts electric (MWe). Two mechanical draft cooling towers are used, drawing water from the Cedar River (Figure 2-2). Water used in the reactor and most other plant systems is piped in from the site’s well water supply (FPL-DA, 2007a). Other site structures include an administration building, control building, turbine building, radwaste building, low-level radwaste processing and storage building, pump house, intake structure, and off-gas stack. The independent spent fuel storage installation (ISFSI) is located on the northern part of the site’s property (Figure 2-3). The following sections describe key features of DAEC, including reactor and containment systems, cooling water system, and transmission system. Also included in the scope of this chapter are six transmission lines that connect the DAEC to the regional grid.

2.1.1 Reactor and Containment Systems

Conceptually, a BWR design is not difficult to understand. A BWR uses water, which acts as a coolant and neutron moderator (Figure 2-5). A neutron moderator is a substance (e.g., light water) that slows the speed of neutrons allowing them to strike uranium-235 atoms contained within the reactor vessel. As the uranium-235 atoms are struck by the slower moving neutrons, they fission, or split apart (Figure 2-6). When uranium atoms fission, they produce heat. This heat causes the cooling water to boil, producing steam. The steam is directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, which generates electricity. This electricity is transmitted along electrical transmission lines to power homes, offices, businesses, and industries. The steam is directed to a condenser where it cools and converts back to liquid water. This cool water is then cycled back to the reactor core, completing the loop.

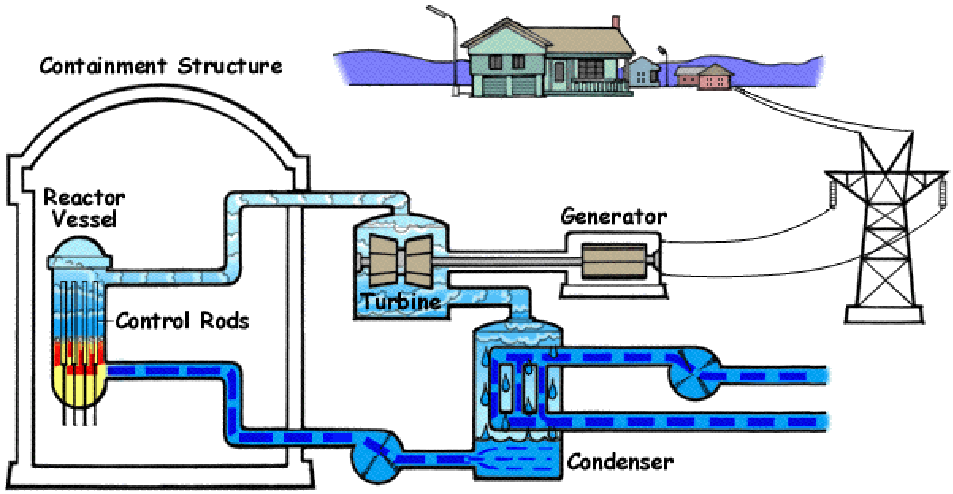


Figure 2-5. Simplified Design of a Boiling Water Reactor (http://www.nrc.gov/reading-rm/basic-ref/students/animated-bwr.html)

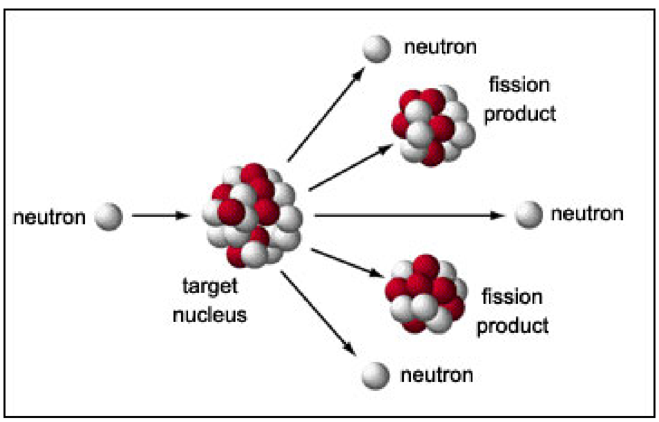


Figure 2-6. The Process of Nuclear Fission. *Figure illustrates how a slow neutron collides with a uranium-235 atom (target nucleus). This collision causes the uranium-235 atom to split into two lighter atoms (fission products). This collision also releases other neutrons that then go on to strike more uranium-235 atoms, producing a sustaining nuclear chain reaction. As the uranium-235 atom splits, it releases energy in the form of heat.* **(http://www.cfo.doe.gov/me70/manhattan/images/FissionChainReaction.gif)**

As indicated earlier, DAEC is a single unit plant with a BWR that uses a BWR-4 reactor design and a Mark I primary containment design. The nuclear steam supply system and the turbine-generator were supplied by GE. The nuclear steam supply system at DAEC is typical of GE BWRs. The balance of the plant was designed and constructed by Bechtel Power Corporation

(BPC) as the architect-engineer and construction contractor. The primary containment for the unit consists of a drywell, a steel structure that encloses the reactor vessel and related piping; a pressure suppression chamber containing a large volume of water; and a vent system that connects the drywell to the suppression chamber. The concrete reactor building, which houses the primary containment, serves as a radiation shield and fulfills a secondary containment function (FPL-DA, 2008a).

The reactor is fueled using slightly enriched (less than 5 weight percent) uranium dioxide pellets sealed in Zircoly-2 tubes with an average batch burnup between 33,000 and 60,000 megawatt days per metric ton uranium. DAEC was originally licensed for a thermal output of 1,658 megawatts thermal (MWt) and a gross electrical output of 541 MWe. In 2001, the plant received a license amendment that increased the thermal output to 1,912 MWt. The generating capacity for the plant was increased to about 610 gross MWe power.

DAEC-generated radioactive waste is addressed in Section 2.1.2. Section 2.1.3 describes DAEC nonradioactive waste streams.

2.1.2 Radioactive Waste Management

The DAEC facility includes a radioactive waste system, which collects, treats, and provides for disposal of radioactive and potentially radioactive wastes that are byproducts of plant operations. Byproducts are activation products resulting from the irradiation of reactor water and impurities therein (principally metallic corrosion products) and fission products resulting from defective fuel cladding or uranium contamination within the reactor coolant system. Radioactive waste system operating procedures ensure that radioactive wastes are safely processed and discharged from the plant within the limits set forth in the *Code of Federal Regulations* (CFR), 10 CFR Part 20, “Standards for Protection against Radiation,” and 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.”

The DAEC produces radioactive wastes in the form of liquid, gaseous, or solid waste streams. Radioactive liquid wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Radioactive gaseous wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the reactor coolant system, solids that contacted reactor coolant system liquids or gases, or solids used in the reactor coolant system or the power conversion system.

When reactor fuel has been exhausted, a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 24 months. Spent fuel assemblies are stored in the spent fuel pool. In addition to the spent fuel pool, spent nuclear fuel is stored in dry casks, located in a secure area onsite (FPL-DA, 2008a).

2.1.2.1 *Radioactive Liquid Waste*

A liquid radioactive waste system consists of subsystems that allow liquid wastes from various sources to be segregated and processed separately. Radioactive liquids are recycled within the plant to the extent practicable. Although allowed by U.S. Nuclear Regulatory Commission (NRC) regulations, the DAEC has not made batch release of liquid radioactive waste into the Cedar River since 1985. The liquid waste is processed, solidified, and shipped offsite for disposal.

Cross connections between the subsystems provide flexibility to process the wastes by alternative methods. Liquid wastes are classified, collected, and treated as high purity, low purity, chemical, detergent, sludge, or spent resins. The terms high purity and low purity refer to the conductivity and not the radioactivity. The liquid waste system design provides for the filtration and demineralization of effluents. Organics in the radioactive liquids may be processed by an ultraviolet ozone treatment system (FPL-DA, 2008a).

DAEC radioactive effluent release reports for 2004 through 2008 for liquid effluents were reviewed by the NRC Staff (Staff) (FPL-DA 2005b, 2006, 2007b, 2008b, 2009a). As reported by the applicant, there were no routine, periodic liquid batch discharges into the Cedar River. As indicated earlier, the liquid waste is processed and solidified for shipment to a disposal facility; however, there were small volume discharges from the sanitary sewage facility in 2007 and 2008 that contained small amounts of tritium. Tritium in the sanitary sewage facility originated from radioactive gaseous effluents discharged from the plant. Tritium, in the form of tritiated water vapor, was condensed by building air conditioning units and air compressors. Condensation is routed to the sewage treatment facility and the transformer pit. This mechanism was validated by the applicant's radiological environmental monitoring program (FPL-DA, 2008b, 2009a). All samples were within NRC standards.

Based on the liquid waste processing system's performance from 2004 through 2008, the liquid discharges from the sanitary sewage system for 2008 are consistent with the radioactive liquid effluents discharged from 2004 through 2007. The applicant is expected to maintain its zero radioactive liquid effluent policy during the license renewal term. The quantities of reported radioactive liquid wastes are reasonable and no unusual trends were noted.

2.1.2.2 *Radioactive Gaseous Waste*

The facility's gaseous waste disposal system processes and disposes of radioactive gaseous effluent to the atmosphere. Gaseous wastes are processed through a recombiner-charcoal delay system to reduce radioactive materials in gaseous effluents before discharge to meet the dose limits in 10 CFR Part 20 and the dose design objectives in Appendix I to 10 CFR Part 50. Gaseous effluents are released to the atmosphere from the plant's offgas stack. Gaseous effluents are continuously monitored and the discharges are terminated if the effluents exceed pre-set radioactivity levels (FPL-DA, 2008a).

Radioactive effluent release reports for 2004 through 2008 for gaseous effluents were reviewed by the Staff (FPL-DA 2005b, 2006, 2007b, 2008b, 2009a). Based on the gaseous waste processing system's performance from 2004 through 2008, the gaseous discharges for 2008 are consistent with the effluents discharged from 2004 through 2007. Variations on the amount of radioactive effluents released from year to year are expected based on the overall performance of the plant and the number and scope of outages and maintenance activities. The radioactive gaseous wastes reported by DAEC are reasonable and no unusual trends were noted.

2.1.2.3 *Radioactive Solid Waste*

The radioactive solid waste system processes wet and dry solid wastes. The wet solid wastes are composed of spent demineralizer resins and filter sludge that are byproducts of plant water treatment processes. The dry solid wastes consist of air filters, contaminated clothing, and used reactor equipment generated from operation and maintenance activities (FPL-DA, 2008a).

Because of differences in radioactivity or contamination levels of the many wastes, various methods are employed for processing and packaging. The disposition of a particular item of waste is determined by its radiation level, type, presence of hazardous material, and the availability of disposal space. Compressible material is compacted into either 55-gallon drums by a hydraulic press or metal containers by a box trash compactor.

DAEC also generates and temporarily stores small quantities of low-level mixed waste (LLMW). Low-level mixed waste is waste that exhibits hazardous characteristics and contains low levels of radioactivity. The mixed waste is stored in the Low–Level Radwaste Processing and Storage Facility per DAEC's Treatment Storage and Disposal Permit. When sufficient quantities are amassed, the material is sent to a licensed processor who separates the hazardous material from the radioactive material. The hazardous material is sent to a waste processor for disposition while the radioactive component is sent for offsite burial at a licensed disposal facility (FPL-DA, 2008a).

The State of South Carolina's licensed low-level radioactive waste (LLW) disposal facility, located in Barnwell, has limited the access from radioactive waste generators located in states that are not part of the Atlantic Low-Level Waste Compact. Iowa is not a member of the Atlantic Low-Level Waste Compact. This has had a negligible affect on DAEC's ability to handle its LLW. Radioactive wastes are shipped to offsite facilities for treatment, disposal, or both. In the past, DAEC has shipped waste to facilities in Pennsylvania and Tennessee for treatment prior to disposal at a permitted radioactive waste landfill in South Carolina or Utah. DAEC primarily uses the Utah facility for disposal. Shipments have been made in accordance with Department of Transportation (DOT) requirements by truck and by rail.

DAEC LLW reports for 2004 through 2008 were reviewed by the Staff (FPL-DA 2005b, 2006, 2007b, 2008b, 2009a). The solid waste volumes and radioactivity amounts generated in 2008 are typical of previous annual waste shipments. Variations in the amount of solid radioactive waste generated and shipped from year to year are expected based on the overall performance of the plant and the number and scope of outages and maintenance activities. The volume and activity of solid radioactive wastes reported by DAEC are reasonable and no unusual trends were noted.

No plant refurbishment activities were identified by the applicant as necessary for the continued operation of DAEC through the license renewal term. Routine plant operational and maintenance activities currently performed will continue during the license renewal term. Based on past performance of the radioactive waste system, and the lack of any planned refurbishment activities, similar amounts of radioactive solid waste are expected to be generated during the license renewal term.

2.1.2.4 *Nonradioactive Hazardous Waste Streams*

The Resources Conservation and Recovery Act (RCRA) governs the disposal of solid and hazardous waste. RCRA regulations are contained in Title 40, "Protection of the Environment," Parts 239 through 299 (40 CFR 239, et seq.). Parts 239 through 259 of these regulations cover solid (nonhazardous) waste, and Parts 260 through 279 regulate hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills.

Solid waste, defined by RCRA, is generated by the facility as part of routine plant maintenance, cleaning activities, and plant operations. Iowa is a part of the Environmental Protection Agency (EPA) Region VII. The EPA authorized the State of Iowa to regulate and oversee most of the solid waste disposal programs, as recognized by Subtitle D of the RCRA. Compliance is assured through State-issued permits. The State of Iowa and local governments are the primary planning, permitting, regulating, implementing, and enforcement agencies for management and disposal of household and industrial or commercial nonhazardous solid wastes in the State. Some of the Federal waste regulations are incorporated by the Iowa Administrative Code (IAC) (IAC 567, Ch.100 - 121).

The EPA classifies certain nonradioactive wastes as "hazardous" based on characteristics including ignitability, corrosivity, reactivity, or toxicity (identification and listing of hazardous waste is available in 40 CFR Part 261). State-level regulators may add wastes to the EPA's list of hazardous wastes. RCRA provides standards for the treatment, storage, and disposal of hazardous waste for hazardous waste generators (40 CFR Part 262). The EPA recognizes three main types of hazardous waste generators (40 CFR 260.10) based on the quantity of the hazardous waste produced:

- Large quantity generators (LQGs) that generate 2,200 pounds (1,000 kilograms (kg)) per month or more of hazardous waste, more than 2.2 pounds (1 kg) per month of acutely hazardous waste, or more than 220 pounds (100 kg) per month of acute spill residue or soil.

- Small quantity generators (SQGs) that generate more than 220 pounds (100 kg), but less than 2,200 pounds (1,000 kg), of hazardous waste per month.

- Conditionally exempt small quantity generators (CESQGs) which generate 220 pounds (100 kg) or less per month of hazardous waste, or 2.2 pounds (1 kg) or less per month of acutely hazardous waste, or less than 220 pounds (100 kg) per month of acute spill residue or soil. DAEC is a small quantity generator of non-acute hazardous waste.

Under the Emergency Planning and Community Right-to-Know Act (EPCRA), applicable facilities are required to provide information on hazardous and toxic chemicals to local emergency planning authorities and the EPA (Title 42, Section 11001, of the *United States Code* (U.S.C.) (42 U.S.C. 11001)). On October 17, 2008, the EPA finalized several changes to the Emergency Planning (Section 302), Emergency Release Notification (Section 304), and Hazardous Chemical Reporting (Sections 311 and 312) regulations that were proposed on June 8, 1998 (63 *Federal Register* (FR) 31268). DAEC is subject to Federal EPCRA reporting requirements, and thus submits an annual Section 312 (TIER II) report on hazardous substances to local emergency agencies.

Wastes that contain both low level radioactive waste and RCRA hazardous waste are referred to as LLMW (40 CFR 266.210). The EPA (or any authorized State agency) regulates the hazardous component of the mixed waste through RCRA, and NRC regulates radioactive waste subject to the Atomic Energy Act of 1954 (AEA). DAEC has not generated any LLMW during the last five years.

The facility generates small amounts of hazardous wastes including spent and expired chemicals, laboratory chemical wastes, and occasional project-specific wastes. Used oil, produced during operation of DAEC, is sent offsite to the EPA-approved hazardous waste disposal facility (FPL-DA, 2008a). The EPA classifies several hazardous wastes as universal wastes; these include batteries, pesticides, mercury-containing items, and fluorescent lamps. In the State of Iowa, EPA Region VII administers Federal universal wastes regulations (EPA, 2009a).

Biocide and chemical wastes are generated during normal operating processes at DAEC that control the pH of the coolant, control scale and erosion in the cooling system, and clean and mechanically remove biofouling microorganisms from water circulation piping. The periodic use of chlorine and bromine in the water circulating system and cooling water system is stipulated in DAEC National Pollutant Discharge Elimination System (NPDES) permit No. 5700104, issued by the Iowa Department of Natural Resources (IDNR) (FPL-DA, 2008a).

2.1.2.5 *Mixed Waste*

The term “mixed waste” refers to waste that contain both radioactive and hazardous constituents. Mixed wastes are stored in the Low Level Radwaste Processing and Storage Facility per DAEC’s Treatment Storage and Disposal Permit. When sufficient quantities are amassed the material is sent to a licensed processor who separates the hazardous material from the radioactive material. The former is dispositioned by the processor while the radioactive component is sent for offsite burial (DAEC 2005a)

2.1.2.6 *Pollution Prevention and Waste Minimization*

In 2008, FPL-DA initiated a recycling program at DAEC that focuses on pollution prevention, waste minimization, and education of personnel. As a result of the DAEC recycling efforts, 14 tons (12.7 metric tons) of the office paper, 6 tons (5.4 metric tons) of cardboard, 5,000 pounds (2.27 metric tons) of batteries, 6,800 pounds (3.08 metric tons) of electronic waste were recycled in the first four months of the implemented program.

To promote nonradiological waste minimization efforts, the EPA’s Office of Pollution Prevention and Toxics has established a clearinghouse that provides information regarding waste management and technical and operational approaches to pollution prevention (EPA, 2009b). The EPA’s clearinghouse can be used as a source for additional opportunities for waste minimization and pollution prevention at DAEC, as appropriate.

Additionally, the EPA encourages use of Environmental Management Systems (EMSs) for organizations to assess and manage the environmental impact associated with their activities, products, and services in an efficient and cost-effective manner. The EPA defines an EMS as “a set of processes and practices that enable an organization to reduce its environmental impact and increase its operating efficiency.” EMSs help organizations fully integrate a wide range of environmental initiatives, establish environmental goals, and create a continuous monitoring process to help meet those goals. The EPA Office of Solid Waste especially advocates the use of EMSs at RCRA-regulated facilities to improve environmental performance, compliance, and pollution prevention (EPA, 2009c). FPL-DA is taking the initial steps in adopting an International Organization for Standardization (ISO) 14001 EMS at the DAEC site.

2.1.3 Facility Operation and Maintenance

Various types of maintenance activities are performed at DAEC, including inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at DAEC to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel in-service inspection and testing, a maintenance structures monitoring program, and maintenance of water chemistry.

Other programs include those implemented in response to NRC generic communications, those implemented to meet technical specification surveillance requirements, and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit, while others are performed during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic in-service inspection, and scheduled maintenance.

2.1.4 Power Transmission System

Six transmission lines connect DAEC to the regional electric grid, all of which are owned and maintained by Information Technology Council (ITC) Midwest LLC. Unless otherwise noted, the discussion of the power transmission system is adapted from the environmental report (ER) (FPL-DA, 2008a) or information gathered at NRC’s environmental site audit.

Two 345 kV lines connect to an existing 345 kV line, and three 161 kV lines deliver power to three substations (i.e., Washburn, Bertram, and Hiawatha). One additional 161-kV line connects to the Sixth Street Generating Station substation; the additional 161-kV line is not described in the final environmental statement (FES) related to the operation of DAEC (AEC, 1973) because it was constructed in 1978, after publication of the FES. The transmission lines cross through Linn, Benton, and Black Hawk counties, Iowa. In total, the transmission lines associated with the operation of DAEC comprise approximately 1,370 acres (554 hectares (ha)) and span 101 miles (163 km) of transmission line rights-of-way (ROWs). Generally, the transmission line ROWs pass through regions of agriculture and forested land.

Transmission lines considered in-scope for license renewal are those constructed specifically to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)); therefore, the Hills, Hazelton, Washburn, Bertram, Hiawatha, and Sixth Street lines are considered in-scope for this supplemental environmental impact statement (SEIS) and are discussed in detail below.

Figure 2-7 contains a map of the DAEC transmission system. The six transmission lines are as follows (see Table 2-1):

- Hills Line: This 345-kV line extends west for 2.7 miles (4.3 km), at which point it turns south and connects to the Hills substation feed. This line shares a 500-foot (153-m) wide ROW with the Hazelton, Washburn, and the Bertram lines for approximately 0.34 mile (0.55 km), at which point the Bertram line splits off. For the remainder of its length, the line shares a 665-foot (203-m) wide ROW with the Hazelton and the Washburn lines. This line is contained within Linn County.

- Hazelton Line: This 345-kV line extends west for 2.7 miles (4.3 km) parallel to the Hills line and also connects to the Hills substation feed. This line shares a 500-foot (152-m) wide ROW with the Hills, Washburn, and the Bertram lines for approximately 0.34 mile (0.55 km), at which point the Bertram line splits off. For the remainder of its length, the line shares a 665-foot (203-m) wide ROW with the Hills and the Washburn lines. This line is contained within Linn County.

- Washburn Line: This 161-kV line extends west for 16 miles (26 km) to the Garrison substation and then an additional 30 miles (48 km) to the Washburn substation. This line shares a 500- to 665-foott (152- to 203-m) ROW with the Hills and Hazelton lines, as described above, and the remainder of the ROW ranges from 60 to 120 feet (18 to 37 km) wide. This line spans Linn, Benton, and Black Hawk counties.

- Bertram Line: This 161-kV line extends west for 0.34 mile (0.55 km) and then continues southeast for a total distance of 28 miles (45 km) to the Bertram substation. This line shares a 665-foot (203-m) wide ROW, as described above, and then has a 100-foot (30-m) wide ROW for the remainder of the line. This line is contained within Linn County.

- Hiawatha Line: This 161-kV line extends east for 8 miles (13 km) to the Hiawatha substation. This line's ROW varies from 60 to 120 feet (18 to 37 km) in width. The line crosses the Cedar River and is contained within Linn County.

- Sixth Street Line: This 161-kV line extends southwest around the city of Palo and then continues southeast following a railroad corridor to the center of the city of Cedar Rapids. The total length of this line is 16 miles (26 km), and its ROW varies from 60 to 120 feet (18 to 37 km) in width. This line is contained within Linn County.

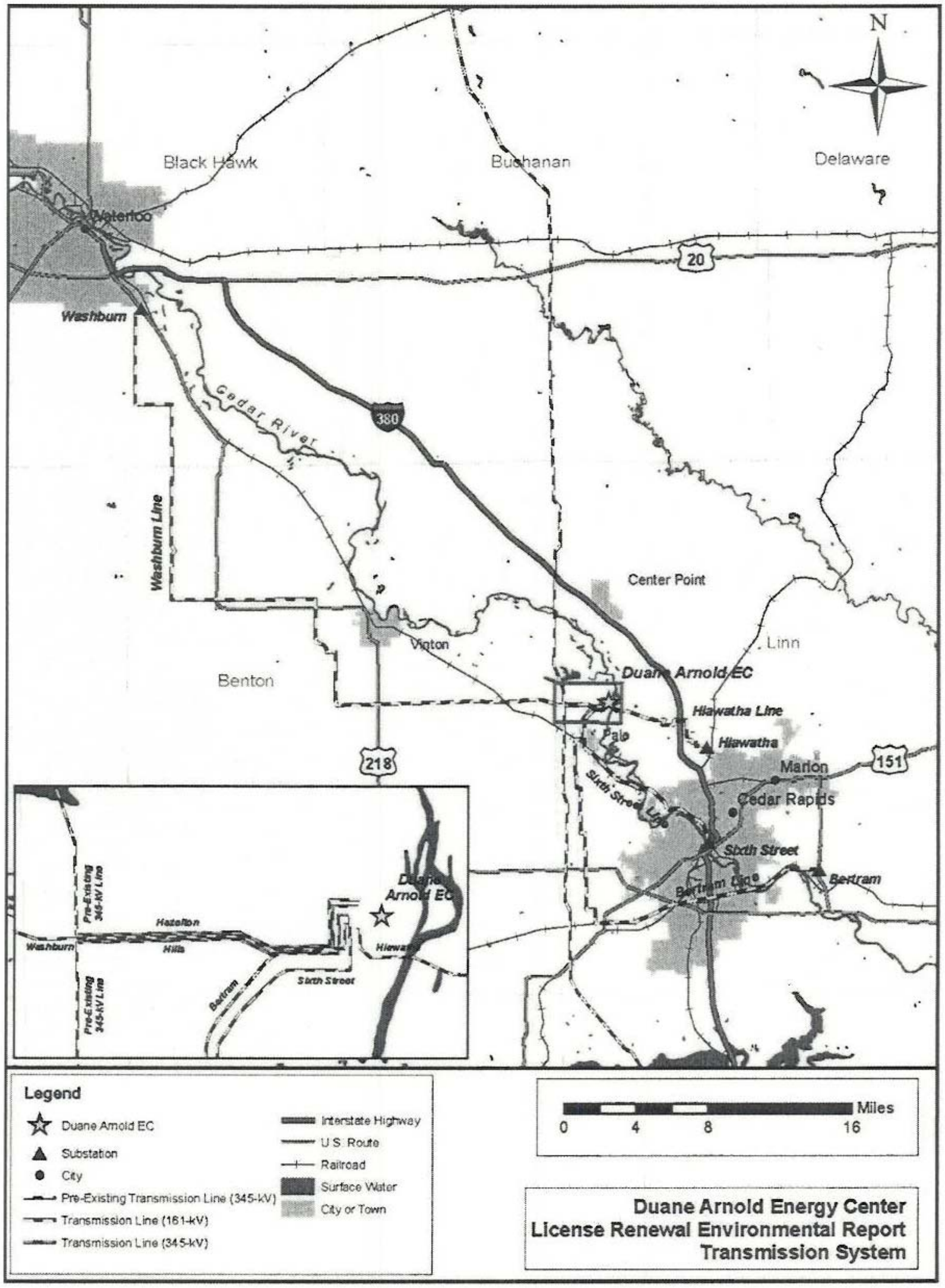


Figure 2-7. Duane Arnold Energy Center Transmission Line System
(Source: FPL-DA, 2008a, Figure 3.1-1)

In addition to these six transmission lines, two substations were constructed for the operation of DAEC; the DAEC substation, located about 0.25 mile (0.4 km) west of the plant, and the Hiawatha substation, located approximately 8 miles (13 km) east of the plant.

ITC employs an integrated vegetative management program, which utilizes a combination of manual, mechanical, biological, and chemical control techniques and is directed by certified foresters and planners. ITC conducts biannual aerial inspections of transmission lines to identify areas that require maintenance. A follow-up ground inspection is completed for any areas that have been marked as requiring maintenance, and a complete span-by-span inspection is completed once every three years. ITC maintains a 26-foot (8-m) clearance for 230-kV lines and a 30-foot (9-m) clearance for 345-kV lines on either side of the lines. The majority of the in-scope transmission lines traverse agricultural land. Those areas that are not already cultivated or developed in some other way are maintained to promote herbaceous vegetation, which includes shrubs, bushes, and other low-growing groundcover. The EPA-approved herbicides may be used to prevent regrowth from tree stumps and to control incompatible woody vegetation. A minimum of a 50-foot (15-m) buffer is maintained in areas near streams and wetlands. ITC maintains a database that includes known threatened and endangered species locations, raptor nests, and natural heritage areas to ensure that workers are aware of areas for which special consideration is required.

All transmission lines were designed and built in accordance with industry standards in place at the time of construction. All transmission lines will remain a permanent part of the transmission system and will be maintained by ITC regardless of DAEC continued operation (FPL-DA, 2008a); however, the Hazelton and Hills lines, which tie into the Hills substation feed, would be deactivated if the DAEC switchyard were no longer in use and would need to be reconnected to the grid if they were to remain in service beyond the operation of DAEC.

Table 2-1. Duane Arnold Energy Center Transmission Lines. *Six transmission lines convey electricity from DAEC to the regional electric transmission system via four ROWs.*

		Approximate Distance		ROW Width[(a)]	Approx. ROW Area[(b)]
Line	**Owner**	**kV**	**mi (km)**	**ft (m)**	**ac (ha)**
Hills	ITC	345	2.7 (4.3)	665 (203)	218 (88)
Hazelton	ITC	345	2.7 4.3)	665 (203)	218 (88)
Washburn	ITC	161	46 (74)	60 to 120 (18 to 37)	502 (203)
Bertram	ITC	161	28 (45)	100 (30)	339 (137)
Hiawatha	ITC	161	8 (13)	60 to 120 (18 to 37)	87 (35)
Sixth Street	ITC	161	16 (26)	60 to 120 (18 to 37)	175 (71)

[(a)]ROW widths for the Washburn, Hiawatha, and Sixth Street lines are approximations and vary along the length of each line.

[(b)]ROW area for the Washburn, Hiawatha, and Sixth Street lines are approximated using 90 feet (27 m) as the average ROW width for these lines.

Source: (FPL-DA, 2008a)

2.1.5 Cooling and Auxiliary Water Systems

DAEC uses a closed-cycle heat dissipation system that withdraws water from, and discharges cooling tower blowdown to, the Cedar River. DAEC employs two cross-flow mechanical forced draft cooling towers to dissipate heat from the plant's steam cycle to the atmosphere. Unless otherwise noted, the discussion of the cooling water system is adapted from the ER (FLP-DA, 2008a), or information gathered at the site audit.

Water that is lost through cooling tower evaporation, wind, and as blowdown returned to the Cedar River is termed "makeup" water. Makeup is withdrawn from the Cedar River via a reinforced concrete intake structure located on the west bank of the river. During low flow, an overflow barrier located across the river intercepts the streambed flow and diverts it to the intake structure, thereby making available the entire flow of river water.

Incoming water is directed into the underground portion of the intake structure and passes through vertical bar racks at a rate of 0.3 feet per second (ft/s) (0.09 meters per second (m/s)). Water then passes through trash racks, spaced 3 inches (8 cm) apart, which removes debris accumulated on the bar racks before the water enters two parallel intake channels. Once water enters the intake channels, it passes through automated wire mesh traveling screens to remove any impinged aquatic organisms or remaining debris. After passing through the traveling screens, the water flows into one of two pump wet pits containing vertical turbine pumps, which empty water into a pipe. Water from the two parallel pathways is then recombined into a single pipe, which discharges into the stilling basin in the pump house. This basin supplies water for the circulating water system, the general service water system, and the fire water system, as well as back-up for residual heat removal service water and emergency service water.

Under normal operation, a maximum of 11,200 gallons per minute (gpm) (25 cubic feet per second (cfs) or 0.71 cubic meters per second (m^3/s)) of makeup water is withdrawn from the Cedar River. This water is circulated through the condenser to dissipate heat and then travels to the cooling towers at a rate of 155,000 gpm (345 cfs or 9.78 m^3/s) per tower, or 310,000 gpm (691 cfs or 19.6 m^3/s) overall. Of the water that is transferred to the cooling towers, 8,100 gpm (18 cfs or 0.51 m^3/s) is lost as evaporative dissipation and 3,100 gpm (6.9 cfs or 0.20 m^3/s) is lost as blowdown, which is returned to the Cedar River. The remaining water, approximately 298,800 gpm (665.7 cfs or 18.85 m^3/s), is recirculated through the condenser for cooling.

2.1.6 Facility Water Use and Quality

The DAEC relies on the Cedar River as its source of makeup water for its cooling system, and it discharges various waste flows to the river. An onsite well system provides groundwater for other site needs. The following sections describe the water use.

2.1.6.1 *Groundwater Use*

Groundwater at the DAEC is present in river alluvium, unconsolidated glacial deposits, and deep sedimentary bedrock formations (FPL-DA 2007c). At the plant, the surficial material is roughly 20 feet (6 meters) of alluvium, comprised of fine to coarse sand with some silt and gravel. It is underlain by roughly 12 to 80 feet (3.7 to 24 m) of clayey glacial till with lenses of sand and gravel. The uppermost bedrock is the carbonate Wapsipinicon and Gower Formations, of middle Devonian and Upper Silurian age, respectively.

The alluvial aquifer is recharged by precipitation and locally by periodic flooding or river recharge. Flow is southeasterly, toward the Cedar River (FPL-DA, 2007c). Groundwater in the bedrock is under confined conditions and also flows toward the river. Minor sand and gravel units may be present within the glacial drift.

Facility production wells are finished in the Wapsipinicon and Gower Formations. During the 2008 flood, the production wellheads are reported to have stayed above water.

DAEC (FPL-DA, 2007d) provided a list of the closest residences to the power plant. All 16 of the residences rely on private well water. They range from 0.5 to 2.3 miles (0.8 to 3.7 km) from the site. The private wells located west and north of the DAEC are hydraulically upgradient of the plant (FPL-DA, 2007a). Some of these wells are within about one mile of the site boundary. Private wells south-southwest of the plant are cross-gradient.

The four onsite production wells provide water for multiple purposes. Approximately 100 gpm is used for demineralizer makeup and less than 10 gpm (0.022 cfs or 0.00063 m^3/s) is used for potable supply (FPL-DA, 2008a). In addition, the largest usage, on the order of 1,400 to 1,500 gpm (3.1 to 3.3 cfs or 0.088 to 0.094 m^3/s), is sent to an air cooling system (FPL-DA 2008A; FPL-DA undated #1). The wells also provide a backup water source for emergency reactor injection, the fire protection systems, and the reactor building closed cooling water (RBCCW) heat exchangers.

The wells are named A, B, C, and D, and have total depths ranging from 285 to 380 feet (87 to 116 m) (IDNR, 2005a). Well B is along the property's west boundary. Wells A and C are in the southwest portion of the property. Well D is approximately 200 feet (61 m) north of the cooling towers and was installed in 1980. Wells A, B, and C were originally shallower, but were replaced by deeper bedrock wells in 2002, 1992, and 1999, respectively. Wells B and D are within their own buildings, while the wellheads for A and C are located outdoors.

Normally, wells D and A run continuously, and wells B and C are used for backup (IDNR, 2008a). The facility is permitted to pump a maximum annual quantity of 1,575 million gallons 5.962 million m^3) from the well system (IDNR, 2005a). Review of annual water use records (e.g., FPL-DA, 2009b) for calendar years 2001 to 2008 indicates an annual groundwater use of 612 to 848 million gallons (2.32 to 3.21 million m^3) .

Water from Well D is chlorinated to allow use in plant systems (heating, ventilation, and air conditioning (HVAC), dry well coolers). The IDNR requires well water to meet drinking water standards if a chlorination system is used.

2.1.6.2 *Surface Water Use*

The DAEC is located in the Cedar River Basin and is built near the west bank of the Cedar River. At the DAEC site, the basin's drainage area is approximately 6,250 square miles (16,200 square km) (FPL-DA, 2007c). The Cedar River is a tributary of the Iowa River, 133 miles (214 km) downstream from DAEC, and the combined flow is a tributary feeding into the Mississippi River.

Between 1903 and 2008, flow in the Cedar River at Cedar Rapids, Iowa varied from a seven-day minimum of 224 cfs (6.34 m^3/s) in December 1989 to a maximum flow of 140,000 cfs (3,960 m^3/s) on June 13, 2008 during intense flooding (USGS, 2008). The average flow at the station is 3,878 cfs. Statistics for the station are presented in Table 2-2. Average flows are lowest in the winter and highest in the spring and early summer.

Table 2-2. Monthly Flow Rates between 1903 and 2008 (Source: U.S. Geological Survey (USGS), 2008)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean flow (cfs)	2,445	2,427	1,870	1,607	2,477	6,609	7,090	5,649	6,379	4,424	3,065	2,455
Mean flow (m^3/s)	69	69	53	46	70	187	201	160	181	125	87	70
Max flow (cfs)	12,100	9,327	8,675	8,529	12,230	17,420	35,320	24,500	46,450	33,910	28,700	13,990
Max flow (m^3/s)	343	264	246	242	346	493	1000	694	1315	960	813	396
Water Year	2008	1973	1983	1973	1984	1929	1993	1991	2008	1993	1993	1993
Min flow (cfs)	463	410	290	299	304	664	1,045	527	350	533	377	466
Min flow (m^3/s)	13	12	8	8	9	19	30	15	10	15	11	13
Water Year	1990	1990	1990	1911	1940	1934	1957	1934	1934	1989	1934	1934

As was described in Section 2.1.6, the Cedar River is the water source for the DAEC circulating water and service water systems. The intake at the river water supply system provides makeup water to the circulating water system to offset the evaporation and blowdown losses at the cooling towers. This reinforced concrete intake also serves as intake for the residual heat removal service water (RHRSW) and the emergency service water (ESW). The intake is located on the west bank of the river; a series of wing dams on the east bank divert the flow toward the intake side. A permitted submerged dam was constructed across the Cedar River to maintain water depth near the intake (Iowa Natural Resources Council, 1971).

The maximum river water requirements are 8,100 gpm (0.51 m^3/s) for evaporative losses and drift from the cooling towers and 3,100 gpm (0.20 m^3/s) for blowdown, for a total withdrawal rate of 11,200 gpm (0.71 m^3/s) (FPL-DA, 2007c). The facility is permitted to withdraw a maximum of 12,575 million (47,602,000 m^3) gallons per year from the Cedar River (IDNR, 2005a) for plant purposes.

As part of DAEC construction, a reservoir was created about 2 miles (47,602,000 m^3) northwest of the power plant, in a tributary to the Cedar River. The purpose of the 410-acre (166 hectare)

Pleasant Creek Recreational Reservoir is to supply water to the Cedar River during low-flow conditions. DAEC may withdraw up to 16,000 acre-feet/year (19,700,000 m^3/yr) from the Cedar River to replenish the Pleasant Creek Reservoir (IDNR, 2005a). The INDR (2005a) allows withdrawal of river water when flow in the Cedar River is greater than 937 cfs (26.5 m^3/s) as measured at a gage in Cedar Rapids. From April 1 to September 30, withdrawal is allowed if flow in Cedar Rapids is between 500 and 937 cfs (14.1 and 26.5 m^3/s), only if flow is increasing on a 24-hour basis. From October 1 to March 31, withdrawal is allowed if flow is greater than 500 cfs (14.1 m^3/s). IDNR (2005a) allows DAEC to discharge water from the reservoir for low-flow augmentation at a rate equal to the DAEC consumptive use.

2.2 AFFECTED ENVIRONMENT

This section provides general descriptions of the environment near DAEC as background information and to support the analysis of potential environmental impacts in Chapter 4.

2.2.1 Land Use

As indicated earlier, DAEC is located on approximately 500 acres of land, 8 miles northwest of Cedar Rapids, Iowa, on the west bank of the Cedar River. The site is approximately 2.5 miles north-northeast of Palo, Iowa, in Linn County (AEC, 1973). The general topographical features in this portion of the Cedar River are broad valleys with relatively narrow flood plains. Across the river from the site, the land rises to an elevation of about 900 feet, and is heavily wooded with sporadic fields or pastures. Away from the immediate vicinity of the river, to the south and west of the site, the land is relatively flat agricultural land, while to the northwest of the site, the land rises and tends to be sparsely wooded farmland.

Only a small portion of the site, consisting of a relatively flat plain approximately 750 feet above mean sea level (msl), is used by the power plant itself, with the remaining land leased for agricultural use (FPL-DA, 2008a). Power plant buildings include the turbine-generator building, control building, reactor building, administration building, pump house and low-level radioactive waste building, which are co-located to form the main plant complex (see Section 2.1). A switchyard, substation, and a large parking lot are located to the west of the main complex. A discharge canal runs from the cooling tower area to the river, where intake and pump house facilities are located. A small sanitary sewage treatment facility is located north of the complex, and an offgas stack is located to the south.

Industrial activities within 10 miles of the site are primarily located in the Cedar Rapids metropolitan area; there is no significant industrial activity near the site (FPL-DA, 2008a). Manufacturing is the single most important industry in Linn County (see Section 2.2.8.6), while employment in smaller communities in the vicinity of DAEC is primarily in small retail establishments.

The Pleasant Creek State Recreation Area, a 1,927-acre park, is located 1 mile northwest of the site. The park includes a 410-acre lake, jointly developed by the Iowa Conservation Commission and the Iowa Electric Light and Power Company to provide both a supplemental water supply for DAEC, and provide regional recreation opportunities (FPL-DA, 2008a). Recreational activities in the vicinity of the site include boating, fishing, hunting, camping, hiking, picnicking, and swimming. Palo Marsh Wildlife Refuge, located 2 miles south of DAEC, is a 144-acre site featuring a wetland trail and bottomland forest for wildlife observation. Wickiup Hill, located across the Cedar River to the east of the site, is a 563-acre natural area and includes the 240-acre Wickiup Hill Outdoor Learning Area and 10,000-square foot Learning Center (FPL-DA, 2008a).

2.2.2 Air and Meteorology

The closest National Weather Service (NWS) station is located in nearby Cedar Rapids, IA (IDNR, 2008b).

All of Iowa is in a humid, continental climate zone characterized by hot humid summers, cold, relatively dry winters, and wet springs. The Iowa Annual Weather Summary for 2008, issued by the Iowa State Climatologist, includes the following data which are representative of some of the weather extremes that are possible in Iowa (IDNR, 2009a). Temperatures averaged 45.8° F (7.67° C), which is about 2 degrees below normal. Precipitation totaled 43.79 inches (111 cm), which is about 9.71 inches (24.67 cm) above normal, making 2008 the 11th coolest and 4th wettest year among 136 years of state weather records. The statewide average rainfall of 9.03 inches (22.93 cm) over the period May 29th to June 12th resulted in widespread flooding over the southeastern two-thirds of Iowa with record flooding down the length of the Cedar River and along portions of the Des Moines, Iowa, and Mississippi Rivers. Cedar Rapids was the hardest hit with a June 13 flood crest 11 feet (3.35 m) higher than the previous record; however, despite record flooding and temporary flooding of site access roads, operations at the DAEC were unaffected.

The State's first F5 tornado since 1976 occurred on May 26, 2008.[1] The NWS reported a total of 105 tornados in the State in 2008, tying 2001 as the second highest annual total behind the 120 tornados that occurred in 2004.[2] Overall, there were 13 fatalities in Iowa in 2008 due to tornados (Iowa State Climatologist, 2009).

Queries of the National Climate Data Center data base resulted in the following additional climate facts: over the period January 1, 1983 to December 31, 2008, Linn County, Iowa experienced 61 flood events, 14 funnel cloud sightings, 29 tornados ranging in intensity from F0 to F4, inflicting property damage as high as $25 million, 235 thunderstorm and high wind events, and no wild fire or forest fire events (NOAA 2009a, 2009b, 2009c, 2009d, 2009e).

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[1] The Fujita six-point scale (F0 to F5) is used to rate the intensity of a tornado based on the damage it inflicts to structures and vegetation. The lowest intensity is F0, the highest is F5. Fujita scale categories are based on estimated (not measured) sustained wind speeds compared against observed structural damage. The Enhanced Fujita Scale replaced the original Fujita Scale in February 2007. The Enhanced Fujita Scale still uses six categories of tornado intensity (EF0 to EF5) but defines those categories differently (NOAA, 2009). Overall, most tornados (around 77 percent) in the United States are EF0 or EF1 and about 95 percent are below EF3 intensity. Approximately 0.1 percent of all tornadoes reach EF5 status with sustained winds in excess of 200 miles per hour (mph) (NOAA, 2008). For additional information about the Fujita Scales, see the NOAA Web site and its hypertext links at: http://www.spc.noaa.gov/efscale/.

[2] The annual average number of tornados in Iowa (since Doppler Radar was installed at NWS) is 56. The annual average for the United States is 1,200 (NOAA, 2009).

2.2.2.1 *Air Quality*

Linn County is in the Northeast Iowa Intrastate Air Quality Control Region (AQCR) (40 CFR 81.256). All of Iowa, including Linn County, is currently in attainment for all National Ambient Air Quality Standards (NAASAQ) (40 CFR 81.316). Recent lowering of particulate matter (PM) at the 2.5 micrometer range ($PM_{2.5}$) standard from 65 to 35 micrograms per cubic meter (ug/m^3) in December 2006 has required a re-evaluation of the compliance status of certain areas of the State. Preliminary monitoring data, compiled by Air Quality Bureau of the IDNR monitoring program, has identified two counties bordering the Mississippi River that may be determined to be non-attainment for the $PM_{2.5}$ standard;[3] however, Linn County continues to be in attainment.

IDNR Air Quality Bureau has primary responsibility for regulating air emission sources within the State of Iowa, and, with the assistance from EPA Region VII and the local programs in Polk and Linn counties, to develop a monitoring plan for the State. IDNR conducts ambient air monitoring in the State. The closest IDNR's ambient air monitoring station to DAEC is located in Cedar Rapids, approximately 8 miles (13 km) northwest from DAEC. Three new monitors ($PM_{2.5}$ standard, sulfur dioxide (SO_2) and carbon monoxide (CO)) were added in 2008 to the Cedar Rapids monitoring site in Linn County (IDNR, 2009a). IDNR annually submits to the EPA, an Iowa Ambient Air Monitoring Network Plan that discusses in detail the establishment, maintenance, and updates of the air quality surveillance system for the criteria pollutants throughout the State of Iowa, as required in 40 CFR Part 58 (IDNR, 2008b).

DAEC qualifies as a minor source[4] under the Title V permit program and therefore is not required to obtain a Title V permit; however, eight stationary pollutant sources on DAEC operate under the auspices of permits issued by the Linn County Health Department: four emergency generators, one auxiliary boiler, one sulfuric acid tank, and two diesel fuel underground storage tanks. These permits establish limits for operation and require annual reports to the county.

Sections 101(b)(1), 110, 169(a)(2) and 301(a) of the Clean Air Act (CAA) as amended (42 U.S.C. 7410, 7491(a)(2), 7601(a)) established 156 mandatory Class I Federal areas where visibility is an important value that cannot be compromised. There are no mandatory Class I Federal areas in the State of Iowa or within 62 miles (100 km) of DAEC. The closest Class I areas are the Boundary Waters National Wilderness Area and Voyageurs National Park in Minnesota, Badlands National Wilderness Area in North Dakota, and Hercules-Glades National Wilderness Area and Mingo National Wilderness Area in Missouri.[5] Given the distances involved and the nature of the stationary air pollutant sources at DAEC, no adverse impacts on Class I areas are anticipated from continued DAEC operation.

The primary meteorological tower is located approximately 1,700 feet (518 m) south-southeast of the reactor building and 1,125 feet (343 m) southeast of the offgas stack (FPL-DA 2005b). Land areas and topography immediately surrounding the tower, as well as the distance of the tower from the reactor building and other permanent structures suggest that no significant

[3] Near real-time ambient air quality data is available at: http://www.iowadnr.gov/air/current/current.html.

[4] Under the Title V Operating Permit program, EPA defines a Major Source as a stationary source with the potential to emit (PTE) any criteria pollutant at a rate > 100 tons/year, or any single hazardous air pollutant (HAP) at a rate of > 10 tons/year or a combination of HAPs at a rate > 25 tons/year.

[5] A complete listing of all Class I areas can be found at 40 CFR 81, Subpart D.

interferences to air flow exist that would compromise the quality of recovered meteorological data; however, volunteer trees and shrubs that become established in proximity to the tower must be continuously eliminated to prevent interferences. Two clusters of instruments are mounted on the primary tower. A lower set of instruments, located at a height of 33 feet (10 m), records wind speed and direction, temperature, and dew point. The upper set of instruments, located at a height of 156 feet (48 m), also records wind speed and direction and temperature.

Meteorological instruments record data digitally and also on strip recorders (used primarily as backup data capture). Digital data are displayed and recorded in the control room and on a backup computer disk, and input into a computerized safety parameter display system (SPDS) to serve as inputs to the emergency response plume dispersion models (if necessary) and for the purpose of establishing a historical record. To guarantee operational reliability, redundant power is supplied to the meteorological instruments and their respective data recorders.

Meteorological instruments are calibrated semiannually, as well as being subjected to routine inspection and maintenance in accordance with the manufacturer’s specifications and DAEC internal procedures, which require visual inspections of the meteorological instruments, verification of the performance through measurements, and documenting the status of the key performance indicators.

2.2.3 Groundwater Resources

Installation of the current set of 12 monitoring wells began in 2006 (FPL-DA, 2007d). The wells are located in six nests (1 through 6), with an A and a B well at each location. The A series wells are about 14–30 feet (4.3–9.1 m) deep, while the B series wells are about 40–60+ (12.2–18.3+ m) feet deep. The wells currently lack a concrete pad at the surface.

Annual radiological environmental monitoring program (REMP) reports document regular samplings of groundwater; reports for the years 2006 and 2007 (Environmental Inc. Midwest Laboratory, 2007, 2008a) were reviewed. These reports represent eight quarters of data, which reflect recent tritium concentration conditions. Quarterly sampling of the site water system and three nearby private wells during 2006–2007 yielded a maximum gross beta of 8.6±2.2 picocuries per liter (pCi/L). Tritium results were all <193 pCi/L. Quarterly sampling of site monitoring wells began midway through 2006 at six well nests, with sampling at all six nests beginning in 2007. The maximum gross beta observed in the available 2006–2007 data was 17.7±1.3 pCi/L in MW-06A. Tritium was consistently highest at MW-01A, with measurements of 287±105 to 644±114 pCi/L. This well is located near the base of the stack, and the relatively high readings are attributed to washout of gaseous effluents (Environmental Inc. Midwest Laboratory, 2008b). These readings are much lower than the EPA threshold for tritium in drinking water of 20,000 pCi/L. Measurements at the other wells were all <198±98 pCi/L, with the exception of one quarter’s sample at MW-05A, which was 269±94 pCi/L.

During the site audit, a representative of IDNR provided a copy of a recent inspection of the water supply system (IDNR, 2008a). The inspection noted a possible cross-connection to be eliminated and several minor deficiencies and recommendations regarding equipment and procedures.

The facility has a 20,000-gallon (76-m^3) sulfuric acid tank with secondary containment, a 50,000-gallon (189-m^3) diesel tank, and a 40,535-gallon (153-m^3) diesel tank. The two diesel tanks are near the reactor. Their liquid level is monitored by a sensor and alarm system and by manual checks. Additional aboveground tanks for gasoline and diesel are located at the south warehouse; these were moved during the rising floodwaters in 2008 (FPL-DA, 2008c).

2.2.4 Surface Water Resources

Cedar River water quality is influenced by non-point source contaminants such as runoff of fertilizer and animal wastes, because most of the basin is agricultural. Point-source discharges from municipal wastewater treatment plants or industries may also affect water quality.

Significant flooding in the Cedar River watershed and elsewhere in the Midwest took place in June 2008, breaching a levy in Cedar Rapids and resulting in evacuations and extensive damage (National Climatic Data Center, 2008). Aerial photos taken on June 11, 2008, and viewed during the site audit, show the key plant areas, including the cooling towers, to be above water. The river covered the ground at the intake structure. Operations continued during the flood; no internal flooding was present in the power block (FPL-DA, 2008c). Because the site ditch for stormwater and wastewater effluent was full, effluent could not flow as normal to its outfall. Instead, the treated effluent was pumped from the wastewater treatment plant over the road to the outfall’s receiving ditch, until the level in the ditch subsided (FPL-DA, 2008c).

The U.S. Geological Survey (USGS, 2008) collected samples at Cedar Rapids on June 19, 2008 to assess the effect of the ongoing flood on water quality. Nutrients in the water included total nitrogen (unfiltered) at 8.76 milligrams per liter (mg/L), orthophosphorous as P (filtered) at 0.146 mg/L, and phosphorous as P (unfiltered) at 0.325 mg/L. Atrazine was measured as 0.92 micrograms per liter (ug/L). A variety of organics were found to be below detection levels. The USGS (2008) notes that prior water quality analyses from Cedar Rapids samples were performed in 1906–1907 and 1944–1954.

New shoreline protection was emplaced in 2008 along the west bank of the Cedar River, downstream of the tributary ditch of stormwater and sewage treatment facility (STF) effluent. This action took place after the 2008 flood to counter erosion that took place during the flooding. The improvement consists of large pieces of limestone.

The EPA granted the State of Iowa the authority to issue NPDES permits, and such a permit implies water quality certification under the Federal Clean Water Act (CWA) Section 401. The State has provided the DAEC with an NPDES permit for Outfalls 001 and 002, subject to effluent limitations, monitoring requirements, and other stipulations (operation is allowed to continue pending state action) as discussed below (IDNR, 2004a). The current permit expired July 5, 2009. An application has been made for a new NPDES permit (FPL-DA, 2008d). A currently valid permit must be in place prior to issuing a license renewal.

Outfall 001 is the discharge point for cooling tower blowdown and stormwater runoff. It is located near the power block in a discharge canal. The outfall is a pipe entering the canal; stormwater enters via another pipe about 30 feet (9 m) away. Effluent limitations are focused on pH, chlorine, chromium, zinc, acute toxicity, and duration of chlorine discharge. At Outfall 001, monitoring requirements include the following parameters, at varying sample frequencies: flow, pH, total residual chlorine, chromium, temperature, zinc, duration of chlorine discharge, acute toxicity, and visual observation. Monthly reporting is required.

For the cooling water system, the State (IDNR, 2003) has permitted the use of Spectrus CT 1300 (Betz), Spectrus NX 1107 (Betz), Spectrus OX 1201 (Betz), or Macrotech, Inc.'s electrolytic copper technology.

The effluent from Outfall 001, along with stormwater, flows in a narrow open ditch toward the Cedar River. At the riverbank, the flow enters an 18-inch (46-cm) diameter pipe with a reducer to 15-inch (38-cm) diameter, flows under a sheet pile structure, and is released in a diffuser along the bottom of the river. The pipe openings are oriented so that discharge is aimed downstream and upward at a 20 degree angle. The diffuser is cleaned out using suction equipment. When flow in the canal exceeds 4,000 gpm (9 cfs or 0.25 m^3/s), such as during heavy precipitation, flow goes over a weir at the discharge structure, into an open canal, and then into the river.

IDNR (2005b) granted a Water Quality Certification pursuant to Section 401 of the Clean Water Act for the construction of four spur dikes (or wing dams) on the Cedar River and for dredging. The approval includes mechanical dredging of a 1,250-foot (381-m) long by 50-foot (15-m) wide channel, with future maintenance dredging as needed. Dredged materials were to be hauled to an upland disposal site on the DAEC property. These actions were also approved by the U.S. Army Corps of Engineers (USACE) (Department of the Army, 2005).

Prior to the installation of wing dams, dredging near the intake is reported to have taken place annually. Dredged sediments were used to create the site firing range under permit of USACE (Department of the Army, 2005; IDNR, (2005b). Following the 2008 flood, river flow had lowered the river bottom near the intake to a level 12 feet (3.7 m) below the minimum level (IIHR, 2008). Therefore, no channel dredging is anticipated in the near future.

Outfall 002 is the discharge point for a sequencing batch reactor wastewater treatment plant treating domestic wastewater and stormwater. It is located where the plant's discharge pipe enters a ditch across the street from the plant. The DAEC STF began operating in 1988 and has a design capacity of 54,000 gallons (204 m^3) per day based on a 30-day average. Wastewater passes through the comminutor (grinder) before entering the first of two sequenced batch aerobic digesters for processing. Sludge, which is sampled once per year, is transferred to the nearby aerobic digestion tank for stabilization, and the wastewater is disinfected by chlorination prior to discharge at Outfall 002 (FPL-DA, 1988). The STF is operated by a contractor. Approximately 9,500 gallons (36 m^3) per day of water are discharged to the Cedar River. The discharge flows in a pipe under the road to the south, discharging to an open ditch. Flow then mixes with stormwater in the ditch and is conveyed to the river at a point approximately 0.4 miles (0.6 km) upstream of the location of the intake and the discharge (blowdown) canal.

Effluent limitations are focused on a 5-day carbonaceous biochemical oxygen demand (5CBOD), total suspended solids (TSS), hydrogen-ion concentration or pH, total residual chlorine, and fecal coliform. At Outfall 002, monitoring requirements include the following parameters, at varying sample frequencies: 5CBOD, TSS, hydrogen-ion concentration or pH, temperature, flow, chlorine, fecal coliform, settleable solids, visual observation, dissolved oxygen, and mixed liquor suspended solids. Sampling stations for particular parameters may be in the raw wastewater, the final effluent, the aeration basins, or the digester. Monthly reporting is required.

As described earlier, an application has been made for a new NPDES permit (FPL-DA, 2008d). The application's attachment list includes a list of proposed chemical additives for the term of the new permit (Table 2-3). The application notes an additional discharge under discussion with the IDNR. It is located near Outfall 001. The discharge is approximately 15 to 25 gpm (56 to 96 liter per minute) continuously, with an additional 100 gpm (378 liter per minute) for six minutes, three times per day. The source of water is outflow from an inline corrosion monitor, inline pH monitors, the pump house sump pumps, and periodic strainer backwash from the general service water system.

Table 2-3. Chemical Additives Listed in National Pollutant Discharge Elimination System Application (Source: FPL-DA, 2008d)

Outfall	Manufacturer	Product	Usage Rate	Purpose	Injection Point
001	GE Betz	Continuum AEC 3110	50 gal/day (189 liter per day)	Corrosion Inhibitor	Cooling Tower
001	GE Betz	Spectrus BD1501E	10 gal/day (38 liter per day)	Minimize Scaling	Cooling Tower
001	GE Betz	Inhibitor AZ8100	Currently not in use	Corrosion Inhibitor	Cooling Tower
001	K.A. Steel Chemicals	Sodium Hypochlorite	200 gal/day (757 liter per day)	Algaecide	Cooling Tower
001	Koch Sulfur Products	Sulfuric Acid 93%	1,000 gal/day (3,785 liter per day)	pH Balance	Cooling Tower
001	GE Betz	Spectrus NX1007	5 gal/week (19 liter per week), summer only	Biocide	Cooling Tower
001	GE Betz	Corrshield MD4100	<10 gal/year (<19 liter per year)	Corrosion Inhibitor	Closed Cooling Systems
001	GE Betz	Spectrus NX1105	(<0.26 gal/year) <1 liter/year	Biocide	Closed Cooling Systems
001	GE Betz	Spectrus NX1106	(<0.26 gal/year) <1 liter/year	Biocide	Closed Cooling Systems
002	FMC	Soda Ash	50 lbs/week (23 kg/week)	pH Balance	Sewage Treatment Basins

DAEC has a stormwater pollution prevention plan (FPL-DA, undated #2). The plan includes a listing of potential sources of pollutants and associated best management practices.

A clay-lined sluice pond is located outside and south of the reactor area. In case of an event at the low-level radwaste processing and storage buildings, the pond would receive and retain its stormwater runoff. The sluice pond has no sampling program.

During the 2008 flood, effluent was pumped overland to the ditch because a high water level in the ditch was preventing normal gravity flow from the STF. Chlorination continued during this flood event.

The STF is listed in a State Web site as having no health-based violations in the last ten years (IDNR, 2009b). The Web site does, however, describe monitoring violations since 2005. These include three violations for three parameters (coliform, total trihalomethanes, and total haloacetic acids), each taking place in 2007–2008. State compliance was later achieved for total trihalomethanes and total haloacetic acids.

At the site audit conducted by NRC, an IDNR representative provided a recent STF inspection report (IDNR, 2007b) and a written response (FPL-DA, 2007e). The response showed adequate resolution regarding modification of equipment and procedures.

The NPDES permit prohibits any discharge of polychlorinated biphenyl (PCB) compounds such as those used for transformer fluid. Cooling tower blowdown resulting from maintenance chemicals may not contain any of the 126 priority pollutants listed in Appendix "A" of 40 CFR Part 423 except for chromium and zinc, as limited in the permit requirements. Neither free available chlorine nor total residual chlorine may be discharged from any source for more than two hours in any one day and not more than one source may discharge free available or total residual chlorine at any one time. No chemicals may be added to the circulating water system during offline conditions. The permit also calls for periodic sampling of the blowdown; stipulations on the frequency, duration, and concentration of molluscide treatments for zebra mussels; sewage sludge disposal requirements; and adherence to a stormwater pollution prevention plan.

The IDNR (2009c) maintains Web-based information tracking systems that include DAEC data. Listed are 21 inspection dates from 1977–2007. No enforcement actions are noted. Monthly reported data are available from July 2004 to December 2008. These include several exceedences for the 5CBOD, total residual chlorine, TSS, and pH. The EPA (2009d) maintains a similar database tool, which tracks the monitoring data for the past 12 quarters. In three quarters from first quarter 2006 to fourth quarter 2008, the exceedences for 5CBOD were determined by EPA to be significant. TSS were significantly high in one quarter.

Annual REMP reports document regular sampling of surface water; reports for 2006 and 2007 (Environmental Inc. Midwest Laboratory, 2007, 2008a) were reviewed. Monthly results for 13 or more radioisotopes at the plant intake, the plant discharge (Outfall 001), an upstream location, a downstream location, and the Pleasant Creek reservoir were all below the laboratory reporting limit; tritium for example was <193 pCi/L in each case. At the STF discharge (Outfall 002), however, measurable activity concentrations ranging up to 382±98 pCi/L of tritium were observed in 7 of the 24 monthly samples. For the other months, tritium was <193 pCi/L, and the other 12 radionuclides were all below laboratory reporting limits. Environmental Inc. Midwest Laboratory (2008b) attributes the relatively high tritium readings in the summer to condensation of tritiated water vapor by plant air conditioner systems. Several elevated wintertime readings were attributed to radiation workers breathing tritium water vapor in the work environment and releasing this tritium in their urine.

2.2.5 Description of Aquatic Resources

DAEC is located within the Cedar River Valley in Linn County, Iowa, on the western bank of the Cedar River, which is the largest tributary of the Iowa River. The headwaters of the Cedar River are located in Dodge County, Minnesota, where its tributaries, the Little Cedar and the Shell Rock rivers merge. The Cedar River flows southeast for 329 miles (529 km) through Iowa to its confluence with the Iowa River in Columbus Junction, Louisa County, Iowa, about 30 mi (48 km) upstream of the mouth of the Iowa River (Sullivan, 2000). The combined Cedar River and Iowa River Basins account for 12,640 mi^2 (32,740 km^2) and are generally characterized by fertile farmland (Sullivan, 2000).

In June 2008, heavy rainfall from late May to early June across the Midwest region caused major flooding events. The Iowa Statewide average rainfall was 9.03 inches (22.9 cm), which is 6.58 inches (16.7 cm) above the normal level for the time period (NWS, 2009). The city of Cedar Rapids, located approximately 5.7 miles (9.2 km) southeast of DAEC, underwent mandatory evacuation in anticipation of the Cedar River water level rising above the city's levee. On June 12, 2008, the levee broke, and approximately 1300 city blocks, or 9.2 mi^2 (15 km^2) were submerged (MCEER, 2009). The Cedar River at Cedar Rapids rose to 31.10 ft (9.48 m), representing a 500-year recurrence interval and setting a new record flow of 150,000 cfs (4250 m^3/s) (IWSC, 2009). The Cedar River rose to a level 11.44 feet (3.49 m) higher than the previous record of 19.66 feet (5.99 km) set on March 31, 1961 (IWSC, 2009).

2.2.5.1 *Benthic Macroinvertebrates*

Benthic macroinvertebrates were monitored at the DAEC site from 1971 through 1999. McDonald (2000) observed that a diverse community of macroinvertebrates was unlikely to inhabit the area due to the riverbed's sandy substrate, which is easily transported; thus, preventing establishment of a macroinvertebrate community. Artificial substrates were placed upstream of, downstream of, and in the discharge canal, and larger and more diverse benthic communities readily developed on these surfaces within a five-week period than what had previously been observed. A total of 30 taxa (26 species of insects, 1 annelid, 1 isopod, 1 nematode, and 1 flatworm) were identified during two sampling periods in September and October of 1999. Nematoceran flies (family Chironomidae) and a species of netspinner caddisfly (*Hydropsyche bidens*) dominated all four sampling areas. Generally, diversity of organisms was significantly lower in the discharge canal sampling areas than in the river. Development of a diverse benthic community on artificial substrate during the sampling period suggests that the Cedar River's natural substrates, and not poor quality of water, prevent the development of a diverse macroinvertebrate community (McDonald, 2000).

Similarly, in the Cedar River Baseline Ecological Study Annual Report (McDonald,1972) conducted between April 1971 and April 1972, bottom samples in the vicinity of the site only yielded three benthic organisms mentioned in the report— tubificid worms, some chironomid larvae, and a significant population of the mayfly *Stenoma* in rocky, unsilted areas. This study concluded that scarce habitat, rather than water quality, prevented the development of larger, more diverse benthic populations (McDonald, 1972).

2.2.5.2 *Freshwater Mussels*

Approximately 55 species of native freshwater mussels were recorded in Iowa during European settlement; today, about 44 native species and 2 exotic species can be found within Iowa and in the Mississippi and Missouri rivers along the State's border (CVRC&D, 2002). Within Iowa, mussels are historically important sources of food for Native Americans, and in the late 1800s, mussels were harvested for their shells, which were manufactured into pearl buttons until the 1940s (CVRC&D, 2002). Overharvesting for the button industry greatly reduced the numbers of many of the mussel species native to Iowa. Freshwater mussel numbers have also been harmed by river damming because large areas of flowing, oxygenated water becomes low-flowing or stagnant after damming and no longer provides adequate mussel habitat. Competition with exotic mussel species and contaminants also threaten freshwater mussel species.

Helms & Associates (2003) conducted mussel surveys in December 2002 along the west shore of the Cedar River upstream of the DAEC intake canal and found 14 individuals representative of 4 species, all of which are native to Iowa. Samples were collected via timed dive searches and whole-substrate collections along specified transects. The majority (10) of the individuals collected were plain pocketbook (*Lampsilis cardium*) (Helms, 2003), a species common to Iowa waters and found in small creeks to large rivers in a variety of substrate types (CVRC&D, 2002). Additionally, two black sandshells (*Ligumia recta*), one pink papershell (*Potamilus ohiensis*), and one white heelsplitter (*Lasmigona complanata*) (Helms, 2003) were found. Black sandshells and white heelsplitters are classified as uncommon by the IDNR and are generally found in interior rivers and streams (IDNR, 2001a; IDNR, 2001b). Black sandshells prefer riffles with gravel or sand substrate, and white heelsplitters prefer pools with mud of sand substrate (IDNR, 2001a; IDNR, 2001b). Pink papershells are common to Iowa waters and are generally found in the lower reaches of larger tributaries in slower moving waters and silt, mud, or sand substrate (IDNR, 2001c). An additional dead individual, a squawfoot (*Strophitus undulatus*), was collected during the 2002 survey. This species is threatened at the Iowa State level and is found in interior rivers and streams in mud, sand, or gravel substrate (IDNR, 2001d). More information about this species is provided in Section 2.2.7 of this draft SEIS. The study concluded that the substrate within the Cedar River near DAEC provides poor to marginal habitat for mussels, though a small population exists within the area (Helms, 2003).

2.2.5.3 *Fish*

In 1996, the USGS collected data on fish communities in eastern Iowa across 12 sites as part of the National Water-Quality Assessment (NAWQA) Program from mid-September to early October. A total of 56 fish species in 13 families were collected across all sites. Two of the data collection sites were located on the Cedar River: one at Gilbertville, Black Hawk County (upstream of the DAEC site), representative of water quality near both row-crop agriculture and urban development, and one near Conesville, Muscatine County, at the mouth of the Cedar River Basin (downstream of the DAEC site). (Sullivan, 2000)

Minnows (Cyprinids) and suckers (Catastomids) dominated all large river sites that were sampled, including both of the Cedar River sites. At the upstream Cedar River site, minnows accounted for 81 percent of fish collected, followed by suckers (16 percent), sunfish (Centrarchids; 2 percent), catfish (Ictalurids; less than 1 percent), and perch (Percids; less than

1 percent). The most abundant species at the upstream site were spotfin shiner (*Cyprinella spiloptera*; 749 individuals), bluntnose minnow (*Pimephales notatus*; 527 individuals), river carpsucker (*Carpoides cyprinus*; 293 individuals), and sand shiner (*Notropis stramineus*; 130 individuals). At the downstream Cedar River site, suckers accounted for nearly 45 percent and minnows accounted for 43 percent of fish collected, followed by catfish (9 percent); sunfish (2 percent); and herrings (Clupids), temperate bass (Percichthyids), drums (Sciaenids), and gars (Lepisosteids) (each less than 1 percent). The most abundant species at the downstream site were river carpsucker (665 individuals), bullhead minnow (*Pimephales vigilax*; 485 individuals), channel catfish (*Ictalurus punctatus*; 137 individuals), and spotfin shiner (127 individuals). (Sullivan, 2000)

The fish community within the Cedar River sites was rated “fair” by Sullivan (2000) using the States of Ohio and Wisconsin’s Index of Biotic Integrity (IBI). The IBI system integrates information at multiple levels including individual, population, community, and ecosystem to produce a numerical rating of a fish community’s health. Of the six large-river sites, the upstream and downstream Cedar River sites received the second and third highest IBI score, though fish communities at all sites were considered to be somewhat degraded compared to reference conditions. The report concluded that conversion of prairie for agricultural use and the increasing population along the Iowa and southern Minnesota rivers account for the majority of this trend. Eutrophication (excessive nutrients in a body of water caused by runoff of nutrients such as animal waste, fertilizers, sewage from the land) from agricultural and urban runoff; contamination from pesticides and other chemicals; soil erosion; and sedimentation were also cited as factors that have degraded the aquatic environment in eastern Iowa. (Sullivan, 2000)

From 1979 through 1983, Ecological Analysts, Inc. conducted operational ecological studies for Iowa Electric Light and Power Company in the vicinity of the DAEC site. During the 5-year period, a total of 1347 fish representing 41 species and 8 families were collected. River carpsucker (*Carpiodes carpio*), spotfin shiner (*Cyprinella spiloptera*), and carp (*Cyprinus carpio*) were among the most prevalent fish collected each year, and generally, few differences were observed in species composition over the five years of sampling. During the 1983 sampling year, minnows (Cyprinids) accounted for 79.7 percent of fish collected, followed by suckers (Catastomids; 12 percent), sunfish (Centrarchids; 3.6 percent), catfish (Ictalurids; 2.8 percent), perch (Percids; 0.6 percent), and then herrings, pikes, and silversides (Clupids, Esocidae, and Atherinidae; each 0.1 percent). When compared, these sampling results are similar in species composition and density to the Sullivan (2000) study discussed above. (Ecological Analysts, 1984)

2.2.6 Description of Terrestrial Resources

DAEC is located on the western bank of the Cedar River, a tributary of the Iowa River and, geologically, within the Midcontinent Rift System (MRS). The MRS began to form about 1100 million years ago when tensional stresses, suggested to be the result of a mantle plume, caused a large fracture across the North American continent stretching in an arc from Kansas northeasterly through Lake Superior, and then southeasterly through lower Michigan (Anderson 1997; Bornhorst et al. Undated). Subsequently, compressive stresses forced sedimentary rock upwards, redepositing older rock over new rock (Anderson 1997). Overall, the central portions of Iowa were uplifted as much as 30,000 ft (9,100 m) (Anderson 1997). A unique characteristic of this rift system is that it cuts across a number of Precambrian basement terranes, each of which have different age, structure, and composition (Schmus and Hinze 1985). The rift system encompasses nearly 42,000 mi^2 (67,600 km^2) and is characterized by a central horst bounded by fault zones and bordered by basins (Anderson 1997). DAEC is located just east of the Williamsburg Basin, which is characterized by clastics, or rocks composed of pre-exisiting sedimentary rock, that was formed from the MRS. Black Hawk County, through which the Washburn transmission line passes, contains MRS clastics that reach thicknesses of up to 8000 ft (2400 m) (IDNR 2006).

The portion of the Cedar River on which the DAEC site is located generally consists of broad valleys and narrow floodplains and has an elevation of 750 ft (230 m) above msl. The DAEC site encompasses approximately 500 ac (200 ha), of which about 140 ac (57 ha) contain the generating facility, associated buildings, switchyard, parking lots, and mowed areas (FPL-DA, 2008). Of the remaining 360 ac (143 ha), about 126 ac (51 ha) is leased for agricultural use, and the remaining land is composed of oak-hickory forest, marsh, and riparian and floodplain habitat (FPL-DA, 2008a).

Predominating floodplain and riparian vegetation include silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), box elder (*A. negunde*), and hawthorn (*Crataegus mollis*) (Neimann and McDonald, 1972). Understory species are less common within the vicinity of the DAEC site due to periodic flooding of the river floodplain.

A variety of wildlife is known to inhabit the DAEC site, including white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*), opossum (*Didelphis virginiana*), spotted skunk (*Spilogale putorius*), and striped skunk (*Mephitis mephitis*) (FLP-DA, 2008a; Collins and MacDonald, 1972). Commonly observed birds include meadowlark (*Sturnella* spp.), barn swallows (*Hirundo rustica*), red-wing blackbirds (*Agelaius phoeniceus*), blue jays (*Cyanocitta cristata*), and wood duck (*Aix sponsa*) (FLP, 2008a). Bird surveys conducted for the FES, related to the operation of DAEC (AEC, 1973) also included pheasants and quail in the wooded areas as well as doves and crows.

The U.S. osprey (*Pandion haliaeetus*) population declined significantly between 1950 and 1970 due to the species' sensitivity to the insecticide dichlorodiphenyltrichloroethane (DDT) and other chemicals (Cornell, 2003). After DDT was banned from use in 1972, the species' numbers began to increase, but migration to new breeding areas remains low. The species is not endangered nor threatened at the Federal or State level; however, State agencies have been working together to expand the bird's breeding range because ospreys experience suppressed reproductive ability as the population becomes more dense, as has been observed in the Great Lakes population. In July of 2004, the IDNR released 24 42-day-old ospreys at five sites around the state in an effort to expand the species' distribution (IDNR, 2004b). The young ospreys were relocated from areas in Minnesota and Wisconsin so that surviving mature birds will return to Iowa to nest within three to four years of release. During this effort, five ospreys were released at Wickiup Hill, which is located just east of the site and across the river (IDNR, 2004b). As of 2005, IDNR has recorded an active osprey nest at Hartman Reserve in Black Hawk County, and as of 2007, an active osprey nest at Wickiup Hill in Linn County (IDNR, 2008c). The pair that returned to Wickiup Hill is believed to be a pair that was released in 2006 (Fritzell, 2008). The pair incubated eggs in 2007, though none hatched (Fritzell, 2008). In 2008, three young hatched, but did not survive a storm in June (Fritzell, 2008). In July 2007, a nest site on the 280-

ft (85-m) DAEC meteorological tower was discovered (Fritzell, 2008). The pair is believed to be a separate nesting pair from the one recorded at nearby Wickiup Hill, though specific banding of the pair is unknown (Fritzell, 2008). The pair returned in 2008, however neither year resulted in successful hatching (Fritzell, 2008). DAEC staff has consulted with IDNR concerning the potential construction of artificial nesting platforms for the birds (FPL-DA, 2008a).

DAEC maintains a U.S. Fish and Wildlife Service (FWS) Permit (FWS, 2009a) for depredation of turkey vultures. In the past, turkey vultures have nested on and caused interference with the communication towers on the site. This permit allows specified DAEC staff members to take four turkey vultures per year in the threatened area, which is defined as “private property or real property in danger of harm to its commercial value or recreational use” (FWS, 2009a). DAEC must submit an annual report to USFWS on January 31 of each year as a requirement of the permit. The 2008 Depredation Annual Report (FPL-DA, 2009c) specified that three turkey vultures had been killed in the 2008 calendar year. DAEC first sought this permit in 2008 and has since renewed it once. The current permit expires on March 31, 2010.

Four parks or designated wildlife areas are located near the DAEC site:

- Pleasant Creek State Recreation Area is a 1927-ac (780-ha) park that is located 1 mi (0.6 km) northwest of the site (FPL-DA, 2008a). The park contains a 410-ac (166-ha) lake and is designated as an Important Bird Area in Iowa (IDNR, 2009d). Over 200 bird species have been recorded within the park, including the threatened Henslow’s sparrow (*Ammodramus henslowii*), which is known to nest on the south end of the lake (IDNR, 2009d).
- Lewis Preserve is located about 2 mi (2.4 km) north of the site and just east of the Pleasant Creek State Recreation Area.
- The Palo Marsh Natural Area covers 144 ac (58 ha) and is located 2 mi (1.2 km) southwest of the DAEC site and just north of the town of Palo (FLP-DA, 2008).
- Wickiup Hill encompasses 563 ac (228 ha) across the Cedar River and just east of the DAEC site. This area includes the Wickiup Hill Outdoor Learning Center, which hosts educational, historical, and cultural events.

2.2.7 Protected Species

Tables 2-4 and 2-5 list threatened, endangered, or candidate species known to occur in Linn County (in which DAEC is located) or Benton or Black Hawk counties (through which transmission line ROWs are associated with DAEC traverse).

2.2.7.1 *Aquatic Species*

No Federally or State-listed aquatic species are known to occur on or within the vicinity of the DAEC site (FWS, 2009b; IDNR, 2009e). However, one previously dead squawfoot mussel (*Strophitus undulatus*) was recovered during a 2002 mussel survey (Helms, 2003) that was conducted on the west bank of the Cedar River upstream of the DAEC intake canal, which indicates that this species has the potential to occur within the vicinity of the site. Additionally, the USFWS and IDNR are taking action to restore the Higgins eye pearly mussel (*Lampsilis higginsii*) to the Cedar River downstream of DAEC (FWS, 2009b). Historic records (pre-1965) indicate that the species' natural range included 14 Mississippi River tributaries, including the Cedar River (Miller and Payne, 2007). Recovery efforts are located downstream of DAEC. Impingement and entrainment into the DAEC cooling system is not expected to be a threat, nor is this species Federally or State-listed within Linn, Benton, or Black Hawk counties; therefore, the species is not discussed below in detail.

<u>Squawfoot</u>

The squawfoot (also known as creeper or strange floater) is Iowa State-listed as threatened. The species' range extends throughout the eastern and central United States and parts of Canada. The freshwater mussel species has an oval, moderately compressed, chestnut to dark brown shell with green rays (CVRC&D, 2002). The shell is smooth and shiny with a rounded anterior edge and bluntly pointed posterior edge and total length of up to 4 inches (10 cm) (Cummings and Mayer, 1992). The squawfoot is a habitat generalist and can be found in small- to medium-size interior rivers and streams with mud, sand, or gravel substrate (Cummings and Mayer, 1992). Increasing water temperatures in the spring induce males to release sperm into the water column (Mulcrone, Undated). As females siphon water for food, they also take in the sperm to fertilize eggs in gill sacs (referred to as marsupia) where the fertilized eggs mature into a larval stage (referred to as glochoidia). Squawfoot eggs are fertilized in the summer, and the female carries the eggs through the following spring, at which point the glochidia are released into the water column (NatureServe, 2009). Glochoidia then attach themselves to a host fish parasitically and remain attached until they develop into juveniles. Juveniles then detach from the host and drop to the bottom of the water column (IDNR, 2001d). Squawfoot glochidia have been observed to have a wide range of possible host species, including numerous species of *Cyprinids* and *Ictalurids* (NatureServe, 2009). Juveniles and adults are filter feeders and prefer oxygenated, flowing water (CVRC&D, 2002). Squawfoot are preyed upon by muskrat (*Ondatra zibethicus*), raccoons (*Procyon lotor*), mink (*Mustela vison*), Canadian otter (*Lontra canadensis*), as well as some species of birds. The main causes of this species' decline are pollution from agricultural runoff, pesticides, and other chemicals; damming of rivers; over-harvesting; and competition with exotic mussel species. The species is not known to occur within the vicinity of the DAEC site (IDNR, 2009e).

Table 2-4. Listed Aquatic Species. *The species below are Federally listed and/or Iowa-listed as threatened or endangered species. These species may occur on the DAEC site or within the Cedar River near the DAEC site or along in-scope transmission line ROWs.*

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	County(ies)
Fish				
Ammocrypta clara	western sand darter	-	IT	Black Hawk, Linn
Esox americanus	grass pickerel	-	IT	Linn
Etheostoma spectabile	orangethroat darter	-	IT	Linn
Lampetra appendix	American brook lamprey	-	IT	Benton, Black Hawk, Linn
Moxostoma duquesnei	black redhorse	-	IT	Benton, Black Hawk, Linn
Notropis heterolepis	blacknose shiner	-	IT	Benton, Linn
Notropis texanus	weed shiner	-	IE	Benton, Linn
Freshwater Mussels				
Alasmidonta viridis	slippershell	-	IE	Linn
Anodontoides ferussacianus	cylindrical papershell	-	IT	Black Hawk, Linn
Lampsilis teres	yellow sandshell	-	IE	Black Hawk, Linn
Lasmigona compressa	creek heelsplitter	-	IT	Black Hawk, Linn
Strophitus undulates	squawfoot	-	IT	Black Hawk, Linn
Tritogonia verrucosa	pistolgrip	-	IE	Linn
Venustaconcha ellipsiformis	ellipse	-	IE	Linn

(a) DL = Delisted; E = Federally endangered; T = Federally threatened; - = No listing

(b) IE = Iowa endangered; IT = Iowa threatened

Sources: IDNR, 2009f; IDNR, 2009g; IDNR, 2009h

2.2.7.2 *Terrestrial Species*

Two Federally-listed species, the prairie bush clover (*Lespedeza leptostachya*) and the western prairie fringed orchid (*Platanthera praeclara*), have been recorded within Linn, Benton, and Black Hawk counties (USFWS, 2009b); however, neither of these species is known to occur on the DAEC site (FLP-DA, 2008a). The State-listed species, the peregrine falcon (*Falco peregrinus*), is discussed below because the species was introduced to the site as part of Iowa's

Peregrine Falcon Restoration Project in 2002. The State-listed bald eagle (*Haliaeetus leucocephalus*) is also discussed because the USFWS lists the species as breeding in Linn County as well as wintering along rivers and larger bodies of water in the area (USFWS, 2007a).

Prairie Bush Clover

The prairie bush clover is Federally and Iowa State-listed as threatened. The species is a slender-leaved legume in the pea family with pink to cream flowers that bloom in July (Sather, 1990). The prairie bush clover is endemic to the Midwest and only occurs in Minnesota, Wisconsin, Iowa, and Illinois tall-grass prairie habitat within the upper Mississippi River Valley (USFWS, 2000). In 1990, about 100 known prairie bush clover sites existed, and by 2000, fewer than 40 known sites remained (USFWS, 2000; Sather, 1990). Loss of prairie habitat is attributed to this species' decline (USFWS, 2000). According to the IDNR Natural Areas Inventory Database, the species occurs in all three counties associated with DAEC and its in-scope transmission lines (IDNR, 2009b; IDNR, 2009c; IDNR, 2009d); however, the species is not known to occur on the DAEC site. No critical habitat has been designated for this species (USFWS, 2007a; USFWS 2009).

Western Prairie Fringed Orchid

The western prairie fringed orchid is Federally and Iowa State-listed as threatened. The species is characterized by a single 2.5- to 4-foot (0.8- to 1.2-m) stalk with up to 40 large white flowers and 2 to 5 elongate leaves originating at the base of the plant (Sather 1991). The species only occurs west of the Mississippi River in Iowa, Kansas, Minnesota, Nebraska, North Dakota, and in Manitona, Canada (USFWS, 2004). Historic records indicated the existence of over 160 sites in nine States, whereas today, only 55 sites in 7 States are known to exist (Sather, 1991). Western prairie fringed orchids occur in mesic to wet tallgrass prairie, wet meadows, and remnant native prairie (USFWS, 2004; Sather, 1991). Conversion of prairie for agricultural use, filling in of wetlands, and use of pesticides and insecticides in and near the species' habitat, which reduce numbers of available pollinators, are the major threats to the species (USFWS, 2004). According to the IDNR Natural Areas Inventory Database, the species occurs in all three counties associated with DAEC and its in-scope transmission lines (IDNR, 2009b; IDNR, 2009c; IDNR, 2009d); however, the species is not known to occur on the DAEC site. No critical habitat has been designated for this species (USFWS, 2007a; USFWS, 2009).

Peregrine Falcon

The peregrine falcon is endangered at the Iowa State level. The USFWS formally removed the peregrine falcon from the Federal *List of Endangered and Threatened Wildlife* effective August 25, 1999, though the species continues to be protected under the Migratory Bird Treaty Act (64 FR 46541). Post-delisting monitoring results for the species published in 71 FR 60563 in 2006 estimated the number of breeding pairs across the United States, Canada, and Mexico to be 3005, an increase of 1255 pairs when compared to the 1999 estimate of 1750 pairs at the time of delisting. The monitoring results concluded that the peregrine falcon population is "secure and vital" (71 FR 60563).

Adult peregrine falcons have a bluish-black head and wings, are 14 to 19 inches (36 to 48 cm) tall, and have a wingspan of 39 to 43 inches (99 to 109 cm) (Cornell, 2003). Adults nest from

April to July on high cliffs and bluffs along the Mississippi River. Females lay two to five eggs, which hatch in 28 to 29 days, and young leave the nest within six to nine weeks of hatching (MNDNR, 2008a). Peregrine falcons prey on ducks, pigeons, and other birds, as well as small mammals and insects (MNDNR, 2008a).

Peregrine falcons have been recorded to nest in nine Iowa counties, including Linn and Black Hawk counties; however, prior to current ongoing reintroduction efforts, the last recorded nest in Iowa was in 1956 (IDNR, 2009i). Between 1989 and 1992, Iowa, in coordination with the Peregrine Fund, the Raptor Center at the University of Minnesota, and the Iowa Peregrine Falcon Recovery Team, released 50 peregrine falcons in Cedar Rapids, Des Moines, and Muscatine as part of the Eastern Peregrine Recovery Program (IDNR, 2009i). By 2000, over 900 peregrine falcons had been released across the Midwest region (IDNR, 2009i). Five nesting pairs have been recorded in Iowa (IDNR, 2009i). In 2002, representatives of the Iowa Peregrine Falcon Restoration Project released eight peregrine falcons at a hacking station on the offgas stack on the DAEC site; however, the birds did not return to the site to nest (FLP, 2008a).

<u>Bald Eagle</u>

The bald eagle is threatened at the Iowa State level. The USFWS formally removed the bald eagle from the Federal *List of Endangered and Threatened Wildlife* effective August 8, 2007, though the species continues to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act (72 FR 37346). Each of these acts protects the species by prohibiting killing, selling, or otherwise harming eagles, nests, or eggs. On June 4, 2007, the USFWS published *National Bald Eagle Management Guidelines* (USFWS, 2007b) to ensure the continued protection of the species under the applicable acts.

Bald eagles mature at 4 to 5 years of age and average 8 to 9 lbs (3.6 to 4.1 kg) for males and 10 to 14 lbs (4.5 to 6.4 kg) for females with a 6 to 7.5 feet (1.8 to 2.3 m) wingspan (MNDNR, 2008b). Juveniles have speckled white and brown plumage, which gradually changes to dark brown on the body and white on the head by the time adulthood is reached at about 5 years of age (USFWS, 2007b). Adults usually nest near coasts, rivers, or large bodies of water in old-growth trees, dead trees, or on cliffs (USFWS, 2007b). Females lay eggs between late April and early May in the northern United States, and eggs hatch in 33 to 35 days (USFWS, 2007b). Eaglets generally leave the nest within six weeks of hatching. Bald eagles prey primarily on fish, but also eat waterfowl, small mammals, and carrion.

As part of the USFWS bald eagle regional recovery plan, the State of Iowa aimed to establish 10 active bald eagle nests between 1981 and 2000 (Fritzell, 2008). This goal was more than surpassed; by 1991, 13 active nests were recorded, and, in 1998, the State reported 84 active nests across 42 counties (Fritzell, 2008). The population continued to expand, and by 2008, an estimated 210 active nests in 83 of the 99 Iowa counties have been recorded (Fritzell, 2008). According to the IDNR, bald eagles were recorded as first nesting in Benton, Black Hawk, and Linn counties in 1992, 1993, and 1994, respectively (Fritzell, 2008). No active nests have been observed on or near the DAEC site (FPL-DA, 2008a).

Table 2-5. Listed Terrestrial Species. *This table shows the status of Federally listed and/or Iowa-listed as threatened, endangered, or special concern species (note: none of these species are Federally listed species). These species may occur on the DAEC site or within the in-scope transmission line ROWs.*

Scientific Name	Common Name	Federal Status(a)	State Status(b)	County(ies)	Habitat
Reptiles and Amphibians					
Ambystoma laterale	blue-spotted salamander	-	IE	Black Hawk, Linn	moist woodlands with small ponds
Clemmys insculpta	wood turtle	-	IE	Benton, Black Hawk	large rivers with sandy substrate
Crotalus viridis	prairie rattle snake	-	IE	Benton	prairie; grasslands; pastures
Emydoidea blandingii	Blanding's turtle	-	IT	Black Hawk, Linn	shallow ponds; marshes; swamps
Liochlorophis vernalis	smooth green snake	-	SSC	Benton	fields and meadows; grassy areas
Necturus maculosus	mudpuppy	-	IT	Black Hawk	rivers; streams; canals; lakes
Notophthalmus viridescens	central newt	-	IT	Black Hawk, Linn	temperate forests with semi-permanent ponds
Terrapene ornate	ornate box turtle	-	IT	Benton, Black Hawk, Linn	dry prairie; oak savannahs
Insects					
Euphydryas phaeton	Baltimore butterfly	-	IT	Linn	wet meadows; bogs; marshes
Problema byssus	byssus skipper	-	IT	Linn	tall-grass prairie; coastal marshes
Birds					
Ammodramus henslowii	Henslow's sparrow	-	IT	Linn	grasslands
Buteo lineatus	red-shouldered hawk	-	IE	Benton, Black Hawk	deciduous and deciduous-conifer forest; swamps
Falco peregrinus	peregrine falcon	-	IE	Linn	grasslands; meadowlands
Haliaeetus leucocephalus	bald eagle	DL	IE	Benton, Black Hawk, Linn	forested areas near open water
Mammals					

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	County(ies)	Habitat
Perognathus flavenscens	plains pocket mouse	-	IE	Benton, Black Hawk, Linn	sparsely vegetated areas
Spilogale putorius	spotted skunk	-	IE	Black Hawk	rocky bluffs; canyon stream beds
Plants					
Adoxa moschatellina	muskroot	-	SSC	Benton	damp cliffs and slopes
Astragalus distortus	bent milk-vetch	-	SSC	Benton	sparsely vegetated slopes
Besseya bullii	kitten-tail	-	IT	Benton, Black Hawk, Linn	prairie
Betula pumila	bog birch	-	IT	Black Hawk	bogs; calcareous fens; swamps; lakeshores
Botrychium simplex	little grape fern	-	IT	Black Hawk, Linn	dry fields; marshes; bogs; swamps
Cacalia suaveolens	sweet Indian plantain	-	IT	Benton	nutrient rich wooded areas; shaded, wet streamsides
Carex leptalea	slender sage	-	SSC	Benton	fens; wet meadows
Chimaphilla umbellate	prince’s pine	-	IT	Linn	coniferous woodlands
Cirsium muticum	swamp thistle	-	SSC	Benton	wet meadows; moist wooded areas
Cornus canadensis	bunchberry	-	IT	Linn	woodland edges; bogs
Cypripedium candidum	small white lady’s slipper	-	SSC	Benton	fens; wet prairies
Cypripedium reginae	showy lady’s slipper	-	IT	Black Hawk	bogs; swamps; wet meadows and prairie
Dalea villosa	silky prairie clover	-	IE	Black Hawk	prairie
Decodon verticillata	swamp loosestrife	-	IE	Black Hawk	swamps; shallow water
Dichanthelium borealis	northern panic grass	-	IE	Linn	open woods; fields; shorelines
Eriophorum angustifolium	tall cotton grass	-	SSC	Benton	
Equisetum sylvaticum	woodland horsetail	-	IT	Black Hawk, Linn	moist, open woods; meadows; thickets

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	County(ies)	Habitat
Gaylussacia baccata	black huckleberry	-	IT	Linn	open woodlands; clearings with dry, sandy soils
Hypericum boreale	northern St. John's wort	-	IE	Linn	sunny, well-drained soils in agricultural areas and clearings
Ilex verticillata	winterberry	-	IE	Linn	swamps; marshes
Juncus greenei	Green's rush	-	SSC	Benton	wet meadows; pond and marsh margins
Lechea intermedia	narrowleaf pinweed	-	IT	Benton	dry, sandy soils on hillsides; open woodlands
Lespedeza leptostachya	prairie bush clover	T	IT	Benton, Black Hawk, Linn	prairie
Menyanthes trifoliate	buckbean	-	IT	Linn	shallow ponds; bogs
Mimulus glabratus	yellow monkey flower	-	IT	Linn	streamsides; shorelines; swamps
Oenothera perennis	small sundrops	-	IT	Linn	fields; open woodlands
Ophioglossum pusillum	northern Adder's-tongue	-	SSC	Benton	open fens; bogs; marsh edges; pastures
Opuntia macrorhiza	prickly-pear	-	IE	Linn	open, sandy, rocky areas
Phlox bifida	cleft phlox	-	SSC	Benton	rocky, open wooded areas; ravines
Platanthera flava	tubercled orchid	-	IE	Linn	wet prairies; sedge meadows
Platanthera praeclara	western prairie fringed orchid	T	IT	Benton, Black Hawk, Linn	tallgrass prairie; sedge meadows
Platanthera psycoides	purple fringed orchid	-	IT	Linn	swamps; wet meadows
Polygala incarnate	pink milkwort	-	IT	Black Hawk, Linn	prairie; lakeshores; meadows
Polygala polygama	purple milkwort	-	IE	Linn	pine-oak woodlands; mountain ridgetops
Salix candida	sage willow	-	SSC	Benton	bogs; fens; willow thickets
Salix pedicellaris	bog willow	-	IT	Benton, Black Hawk	bogs; sedge meadows

Scientific Name	Common Name	Federal Status[a]	State Status[b]	County(ies)	Habitat
Selaginella rupestris	ledge spikemoss	-	SSC	Benton	cliffs; rocky outcrops
Spiranthes ovalis	oval ladies-tresses	-	IT	Linn	moist, shady upland forests
Biola lanceolata	lance-leaved violet	-	SSC	Benton	bogs; swamps; wet meadows
Xyris torta	yellow-eyed grass	-	IE	Benton, Linn	bogs; pond margins; fields; dtiches
Snails					
Vertigo meramecensis	bluff vertigo	-	IT	Linn	wooded bluffs; caves

(a) DL = Delisted; E = Federally endangered; T = Federally threatened; - = No listing

(b) IE = Iowa endangered; IT = Iowa threatened; SSC = Iowa species of special concern

Sources: FWS, 2008; IDNR, 2009f; IDNR, 2009g; IDNR, 2009h

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at DAEC. DAEC and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by DAEC operations. DAEC operations, in turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of DAEC depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the areas where DAEC employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The DAEC ROI consists of a two-county area (Linn and Benton counties) where approximately 90 percent of DAEC employees reside, and includes the city of Cedar Rapids. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding the DAEC site.

DAEC employs a permanent workforce of approximately 661 employees (FPL-DA, 2008a). Approximately 90 percent live in Linn, Benton, Johnson and Black Hawk counties, Iowa (Table 2–6). The remaining 11 percent of the workforce are divided among 14 counties in Iowa, with numbers ranging from one to five employees per county, and elsewhere in the United States. Given the residential locations of DAEC employees, the most significant impacts of plant operations are likely to occur in Linn and Benton counties. The focus of the analysis in this SEIS is therefore on the impacts of DAEC in these two counties.

Table 2-6. Duane Arnold Energy Center Permanent Employee Residence by County in 2006

County	Number of DAEC Personnel	Percentage of Total
Linn	504	76
Benton	86	13
Johnson	28	4
Black Hawk	6	1
Others	37	6
Total	661	100

Source: (FPL-DA, 2008a)

DAEC schedules refueling outages at 24-month intervals. During refueling outages, site employment increases by 1,000 workers for approximately 25 to 30 days (FPL-DA, 2008a). Most of these workers are assumed to be located in the same geographic areas as the permanent DAEC staff.

2.2.8.1 *Housing*

Table 2-7 lists the total number of occupied housing units, vacancy rates, and median value in the ROI. According to the 2000 Census, there were almost 91,000 housing units in the ROI, of which approximately 86,500 were occupied. The median value of owner-occupied units was almost $99,500 in Linn County, higher than in Benton County. The vacancy rate was lower in Linn County (4.7 percent) and higher in Benton County (6.1 percent) than in the ROI as a whole (4.8 percent).

By 2007, the total number of housing units in Linn County had grown by almost 12,000 units to 102,748 while the total number of occupied units grew by 8,146 units to 94,645. As a result, the number of available vacant housing units increased by more than 3,700 units to 8,103, or 7.9 percent of total housing units.

Table 2-7. Housing in Linn and Benton Counties, Iowa

	Linn	Benton	ROI
Year 2000			
Total	80,551	10,377	90,928
Occupied housing units	76,753	9,746	86,499
Vacant units	3,758	631	4,389
Vacancy rate (percent)	4.7	6.1	4.8
Median value (dollars)	99,400	82,700	97,494
Year 2007			
Total	91,733	11,015	102,748
Occupied housing units	84,535	10,110	94,645

Vacant units	7,198	905	8,103
Vacancy rate (percent)	7.8	8.2	7.9

Source: USCB, (2009a, b, c)

2.2.8.2 *Public Services*

This section presents a discussion of public services including water supply, education, and transportation.

Water Supply

Water systems in Linn and Benton counties use groundwater sources. The largest water supply system in the two counties is the Cedar Rapids Water Department, which also operates a well system of shallow vertical and collector wells constructed in the sand and gravel deposits along the Cedar River. Because of continuous pumping of the city's wells, most of the water in the aquifer is pulled from the river. The well system consists of four well fields with a total of four collector wells and 45 vertical wells. Local industries use 75 percent of the water and the remaining 25 percent is used by residential, commercial, and municipal customers (CRWD 2005, undated). Table 2-8 lists the largest municipal water suppliers in Linn and Benton counties.

Table 2-8. Major Public Water Supply Systems in Linn and Benton Counties. *Average Daily and Maximum Daily Production and System Design Capacity (gallons per day.)*

Water Supplier [a]	Water Source	Average Daily Production	Design Capacity
Linn County			
Cedar Rapids Water Department	GW	39.4	45.0
Marion Municipal Water Department	GW	2.6	6.5
Benton County			
Vinton Municipal Water Department	GW	0.5	1.2

GW = Groundwater

[a] Source: EPA, (2007a, b)

Education

DAEC is located in the Cedar Rapids Community School District, Linn County. The school district had 35 schools and an enrollment of approximately 17,263 students in 2007. Including the Cedar Rapids Community School District, Linn County had 11 school districts (NCES, 2009), with 34,492 students enrolled in public schools in the county in 2007. Benton County has a total of 3 school districts with an enrollment of 3,988 students in 2007 (NCES, 2009).

Transportation

DAEC is accessed by DAEC Road, which intersects with McClintock Road/Power Plant Road and terminates at Palo Marsh Road/County Road W36, which in turn links Interstate 380 to the north and continues southeast of Palo and terminates at an intersection with Interstate 380 in

Cedar Rapids. Employees commuting from Cedar Rapids could take County Road W36 or take County Road E36 (also known as Blairs Ferry Road) (FPL-DA, 2008a), which has an interchange with Interstate 380 north of Cedar Rapids. Employees commuting from the north would also travel south on County Road W36. Employees from the west or southwest would travel to County Road E36 which intersects with County Road W36 in Palo. Those traveling from the northwest would travel to Interstate 380 and exit at the County Road W36 interchange (FPL-DA, 2008a).

Of the road segments identified, traffic counts are only available for Interstate 380 at County Road E36 (Blairs Ferry Road), (28,800 annual average daily traffic trips) and County Road W36 (F Avenue) (24,100 trips), both in Cedar Rapids (IDOT, 2006). Level of Service (LOS) data, which describes operating conditions within a traffic stream and their perception by motorists, is available only for Interstate 380 in the northern Cedar Rapids metropolitan area (LOS C - stable flow, marking the beginning of the range of flow in which individual vehicle traffic is significantly affected by interaction with the traffic stream) and at the Blairs Ferry Road interchange (LOS D - high-density, stable flow in which speed and freedom to maneuver are severely restricted, where small increases in traffic will generally cause operational problems).

The Linn County Regional Planning Commission's (LCRPC) long-range transportation plan includes improvements to Interstate 380 and Blairs Ferry Road, although the planning area does not include DAEC (LCRPC, 2005). Benton County does not have a transportation plan.

2.2.8.3 *Offsite Land Use*

This section focuses on Linn and Benton counties because the majority of the permanent DAEC workforce (approximately 83.7 percent) live in these counties, and because DAEC pays property taxes in Linn County.

Linn County is 717 mi^2 (458,180 ac) (Linn County, 2003) and is primarily rural outside the Cedar Rapids metropolitan area. Urban area in Linn County comprises approximately 61,000 acres, or 13 percent of the total acreage; the remaining 397,180 acres are unincorporated. Of the acreage located in the unincorporated areas, approximately 16 percent is either developed, considered public lands, or located in critical natural resource areas. The remaining 303,958 acres are in agricultural use or woodlands (Linn County, 2003).

The LCRPC coordinates land use planning, zoning, transportation improvements, water and sewer systems, and other issues among the municipalities and in the Cedar Rapids metropolitan area (LCRPC, 2007). In addition, the City of Cedar Rapids has a comprehensive plan that addresses land use and other issues (Cedar Rapids, 1999). Linn County has a rural land use plan and map that provides the land use policy for the rural portions of the county. The plan is reviewed annually and is intended to serve as a guide for land use decision-making through the year 2020.

Benton County covers 716 mi^2. Farm acreage totals approximately 400,000 acres (FPL-DA, 2008a), about 87 percent of the total land area of the county.

Benton County has a land preservation and use plan that provides the land use policy for the unincorporated areas of the county, ensuring the protection and preservation of agricultural land

and other limited natural resources, while providing for growth in those areas that would be compatible with existing land uses and public facilities and services that are available (Benton County, 1986). The objectives of the plan are met through administration of the Benton County Agricultural Land Preservation Ordinance. The plan and ordinance are reviewed and amended from time-to-time by the Benton County Board of Supervisors (Benton County, 1994).

2.2.8.4 *Aesthetics and Noise*

The DAEC site is bordered on the east by the Cedar River and an associated series of low bluffs, and by hills to the north and west of the plant. The access road to the site runs in a north-south direction; at the southern site boundary the road turns west for a distance of 1 ½ miles before it turns south toward the town of Palo.

A low-profile switchyard and substation are located to the west of the road to Palo, located approximately 700 feet from the outer edge of a large parking lot and about 2,000 feet from the turbine/generator building. The center of the plant building complex is about 1,700 feet from the western side of the north-south reach of the Cedar River, while the center of the switchyard is about 2,500 feet from the river. A discharge canal runs approximately 1,700 feet from the cooling tower area to the river, and an intake and pump house is located a short distance to the north. The turbine-generator building, control building, reactor building, administration building, pump house and low-level radioactive waste building are co-located to form the main plant complex. A small sanitary STF is located a few hundred feet north of the complex, and an offgas stack is located a few hundred feet south of the complex. Dimensions of the main buildings on the 500-acre plant site are 420 x 475 feet (4.6 ac) for the power plant, 500 x 600 feet (6.9 ac) for the cooling towers, and 600 x 1000 feet (13.7 ac) for the switchyard and substation. Except for the offgas stack which rises to a height of 328 feet above ground, the 153-foot reactor building is the tallest onsite structure (AEC, 1973).

Outer walls of all plant buildings consist of light buff-colored concrete. The upper area of the walls of the reactor and turbine-generator buildings are covered with light brown metal siding which has dark brown vertical stripes. The cooling towers are constructed with cedar and fir. All substation and switchyard equipment and supporting structures are painted light gray, and overhead aluminum conductors have a nonreflecting finish. Other areas of the site, which were disturbed during development and construction, have been largely restored and planted with grasses, shrubs, and trees.

The three most significant noise sources associated with the plant are the cooling towers, transformers, and circuit breakers. The impacts of plant operation on outdoor and indoor noise levels were assessed in the FES conducted at the time of plant construction (AEC, 1973).

The cooling towers have a source noise level of 138 decibels (dB). Outdoor noise levels at the nearest farm house and indoor noise levels, assuming typical wall construction with some open windows, would mean that these noise levels would transform the rural environment into an urban environment, and this may prove annoying to the occupants of local buildings, particularly at night. In addition, persons visiting the Wickiup Conservation Area east of the plant, less than 1 mile across the river, would be subjected to an overall sound pressure level of about 55 dB from the cooling towers. This may be annoying to persons visiting the area. The FES concluded that in no case will offsite sound levels from cooling tower operation be of such a magnitude as to cause actual hearing damage (AEC, 1973).

A noise level of 89 db was associated with the transformers located in the turbine building and in the electrical power distribution substation located west of the plant. This noise level is much lower than the noise level at the cooling towers. The sound level at the nearest offsite occupied dwelling closest to the transformers was assumed in the FES to be below the threshold of hearing. Circuit breakers associated with the plant are air-operated and have a source noise level of 181 db. At the nearest occupied dwelling, this would result in momentary sound pressure levels of about 110 db. Exposures to ambient levels of 110 db are of sufficient magnitude to cause possible hearing damage if they are constantly repeated at the rate of one hour per day. At the time of the FES, the applicant estimated that the breakers would operate approximately once per year, meaning that, although sound levels associated with circuit breaker operation are high, they would not result in a serious noise impact (AEC, 1973).

2.2.8.5 *Demography*

In 2000, approximately 210,081 persons lived within a 20-mile (32-km) radius of DAEC, which equates to a population density of 167 persons/mi^2. This density translates to a Category 4 (greater than or equal to 120 persons/mi^2 within 20 miles) using the generic environmental impact statement (GEIS) measure of sparseness (FPL-DA 2008a). At the same time, there were approximately 621,461 persons living within a 50-mile radius of the plant, for a density of 79 persons/mi^2, meaning that DAEC falls into Category 3 (one or more cities with 100,000 or more persons and less than 190 persons/mi^2 within 50 miles (80 km)) on the NRC proximity scale. A Category 4 value for sparseness and a Category 3 value for proximity indicate that DAEC is in a high density population area.

Table 2-9 shows population projections and growth rates from 1970 to 2050 in Linn and Benton counties. The growth rate in Linn County showed a decline of 0.6 percent for the period of 1980 to 1990, but has grown, and is projected to grow, throughout the remainder of the period. A similar pattern of growth can be observed in Benton County, with a decline in population between 1980 and 1990, with population growth expected through 2040.

Table 2-9. Population and Percent Growth in Linn and Benton Counties, Iowa, from 1970 to 2000 and Projected for 2010 and 2040

Year	Linn County		Benton County	
	Population	Percent Growth[a]	Population	Percent Growth[a]
1970	163,213	—	22,885	—
1980	169,775	4.0	23,649	3.3
1990	168,767	-0.6	22,429	-5.2
2000	191,701	13.6	25,308	12.8
2010	211,489	10.3	26,815	6.0
2020	231,345	9.4	27,846	3.8
2030	252,057	9.0	28,980	4.1
2040	273,054	8.3	30,142	4.0

— = No data available.

(a) Percent growth rate is calculated over the previous decade.

Sources: Population data for 1970 through 1990 (USCB, 2009d); data for 2000 (USCB, 2009e); projected population data for 2010 to 2040 (State Library of Iowa, 2008)

The 2000 demographic profile of the ROI population is included in Table 2-10. Persons self-designated as minority individuals comprise 5.5 percent of the total population. This minority population is composed largely of Black or African American and Asian residents.

Table 2-10. Demographic Profile of the Population in the Duane Arnold Energy Center Region of Influence in 2000

	Linn County	Percent of Total Population	Benton County	Percent of Total Population	Region of Influence	Percent of Total Population
Total Population	191,701	100	25,308	100	217,009	100
Race (2000) (percent of total population, Not-Hispanic or Latino)						
White	179,999	93.9	25,015	98.8	205,014	94.5
Black or African American	4,919	2.6	51	0.2	4,970	2.3
American Indian and Alaska Native	418	0.2	37	0.1	455	0.2
Asian	2,634	1.4	43	0.2	2,677	1.2
Native Hawaiian and Other Pacific Islander	91	0.0	4	0.0	95	0.0
Some other race	881	1.5	27	0.1	908	0.4
Two or more races	2,759	1.4	131	0.5	2,890	1.3
Ethnicity						
Hispanic or Latino	2,722	1.4	156	0.6	2,878	1.3
Minority Population (including Hispanic or Latino ethnicity)						
Total minority population	11,702	6.1	293	1.2	11,995	5.5

Source: USCB, (2009f)

Transient Population

Within 50 miles (80 km) of DAEC, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services in some counties within 50 miles of the plant (Table 2-11). In 2000 in Linn County, 0.6 percent of all housing units were considered temporary housing for seasonal, recreational, or occasional use, while temporary housing accounted for only 1.2 percent of total housing units in Benton County. In 2007, there were 18,480 students attending colleges and universities within 50 miles (80 km) of DAEC.

Table 2-11. Seasonal Housing within 50 Miles of Duane Arnold Energy Center, 2000

County [a]	Number of Housing Units	Vacant Housing Units for Seasonal, Recreational or Occasional Use	Percent
Clayton	8,619	717	8.3
Poweshiek	8,556	637	7.4

Delaware	7,682	465	6.0
Jackson	8,949	415	4.6
Louisa	5,133	284	1.7
Others	338,617	2,020	0.6
Total	377,556	4,538	1.2

Source: USCB 2009c
[a] Counties within 50 miles of DAEC with at least one block group located within the 50-mile radius

Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers may follow the harvesting of crops, particularly fruit, throughout the northeastern U.S. rural areas. Others may be permanent residents near DAEC who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be "underrepresented" in U.S. Census Bureau (USCB) minority and low-income population counts.

The 2007 Census of Agriculture collected information on migrant farm and temporary labor. Table 2-12 provides information on migrant farm workers and temporary (less than 150 days) farm labor within 50 miles of DAEC. According to 2007 Census of Agriculture estimates, Linn County hosts relatively small numbers of migrant workers, with 482 temporary farm laborers employed on 211 farms in the county (USDA, 2009). The county with the most temporary farm workers within 50 miles of DAEC was Johnson County with 1,240 workers on 253 farms.

Table 2-12. Migrant Farm Worker and Temporary Farm Labor within 50 Miles of Duane Arnold Energy Center

County [a]	Number of Farm Workers Working for Less that 150 Days	Number of Farms Hiring Workers for Less than 150 Days	Number of Farms Reporting Migrant Farm Labor	Number of Farms with Hired Farm Labor
Johnson	1,240	253	4	319
Fayette	1,101	359	4	420
Clinton	1,021	341	1	411
Dubuque	865	295	4	395
Delaware	855	327	6	444
Others	7,249	4,106	23	4,321
Total	12,331	5,681	42	6,310

Source: USDA (2009)
[a] Counties within 50 miles of DAEC with at least one block group located within the 50-mile radius

2.2.8.6 *Economy*

This section contains a discussion of the economy, including employment and income, unemployment, and taxes.

Employment and Income

Between 2000 and 2008, the civilian labor force in the Linn County area grew at an annual average rate of 0.9 percent to 120,241 (USDOL, 2009). The civilian labor force in the Benton County area grew at an annual rate of 0.7 percent to the 2008 level of 14,501.

In 2006, manufacturing, retail, health care, and social assistance employment represented the largest sector of employment in both counties followed by accommodation and food services (USCB, 2009g). The largest employer in Linn County in 2006 was Rockwell Collins with 7,300 employees (Table 2-13). The majority of employment in Linn County is located in the city of Cedar Rapids.

Table 2-13. Major Employers in Linn County in 2006

Firm	Number of Employees
Rockwell Collins	7,300
Cedar Rapids Community School District	2,800
AEGON USA	2,600
St. Luke's Hospital	2,400
Maytag Appliances	2,200
Mercy Medical Center	2,060
Hy-Vee Food Stores	2,044
MCI	1,528
City of Cedar Rapids	1,493
Kirkwood Community College	1,443
McLeod USA	1,361
Alliant Energy-Interstate Power and Light	1,100
Quaker Foods	1,100

Source: Cedar Rapids Area Chamber of Commerce (undated)

Income information for the DAEC ROI is included in Table 2-14. There are slight differences in the income levels between the two counties. The median household and per capita incomes in Linn and Benton counties were higher than the Iowa average. Only 9.9 percent of the population in Linn County was living below the official poverty level, while in Benton County, 7.2 percent of the population was below the poverty level.

Table 2-14. Income Information for the Duane Arnold Energy Center Region of Influence, 2007

	Linn County	Benton County	Iowa
Median household income (dollars)	53,076	54,417	47,324

Per capita income (dollars)	38,419	32,419	34,916
Percent of persons below the poverty line	9.9	7.2	11.0

Source: USCB (2009g, h)

Unemployment

In 2008, the annual unemployment average in Linn and Benton counties was 4.0 and 4.1 percent, respectively, which was similar to the annual unemployment average of 4.1 percent for Iowa (USDOL, 2009).

Taxes

The owners of DAEC pay annual property taxes to Linn County. A portion of the total is retained for county operations, including public safety and legal services, physical health and social services, mental health services, roads and transportation, administration, and other expenses. Linn County forwards the remainder of the collected tax revenue to the townships, school districts, cities, and other taxing authorities in the county.

During 2005 through 2008, Linn County collected approximately $236 to $262 million annually in property taxes (Table 2-15). DAEC's property tax payments during this period represented 0.3 to 0.4 percent of the total property tax revenues collected in the county. The sale of DAEC by Alliant Energy to Nextera Energy in 2006 resulted in a reassessment of the valuation of the plant, and consequently the amount of property tax paid by the plant to the county. Linn County retained $35 to $41 million dollars each year for its operations over the period 2002 to 2006, with tax payments made by DAEC constituting less than 1 percent of Linn County's total operational costs. More than 50 percent of DAEC tax payments go to Cedar Rapids Community School District, which had expenditures of $159.1 million during 2006–2007 (NCES, 2009).

Table 2-15. Property Tax Revenues in Linn County, 2005 to 2008; Florida Power and Light Property Tax, 2005 to 2008; and Florida Power and Light Property Tax as a Percentage of Total Property Tax Revenues in Linn County

Year	Total Property Tax Revenues in Linn County (in millions of dollars, 2006)	Property Tax Paid by FPL (in millions of dollars, 2006)[1]	FPL Property Tax as Percentage of Total Property Tax Revenues in Linn County[1]
2005	236.0	603.2	0.3
2006	245.3	1,049.2	0.4
2007	259.3	1,135.5	0.4
2008	261.6	844.9	0.3

[1] Includes property taxes paid to all jurisdictions in Linn County

Source: FPL-DA, 2008a

In 1998, the Iowa Legislature established the "Deregulation and Restructuring of the Electric Utility Industry Study Committee" to review restructuring activities and experiences in other States, and at that time, the Committee did not make any formal recommendations. In 1999, the Iowa Utilities Board undertook an extensive study of electricity restructuring and issued a number of reports. In 2000, bills related to the restructuring of the electric utility industry were introduced to the Iowa General Assembly in the legislative session, although the legislative session ended with no further action on the bills. Currently, there has been no new action on the status of deregulating the electric power industry in Iowa (FEMP, 2006). Should deregulation ever be enacted in Iowa, this could affect utilities' tax payments to counties; however, any changes to DAEC property tax rates due to deregulation would be independent of license renewal.

The continued availability of DAEC and the associated tax base is an important feature in the ability of Linn County communities to continue to invest in infrastructure and to draw industry and new residents.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the DAEC and surrounding areas.

2.2.9.1 *Cultural Background*

As indicated earlier, DAEC is located in eastern Iowa along the Cedar River. Archaeological evidence from all major prehistoric periods and the historic period has been found in the vicinity of the plant. There are 74 properties listed on the National Register of Historic Places in Linn County, Iowa. Three of the National Register sites are within 10 miles of DAEC. Two of the sites are bridges and the third is the Taylor Van Note Building in Cedar Rapids. The Wickiup Hill Outdoor Learning Area located across the Cedar River from the DAEC has several Native American mounds on the property. There are more than 40 known archaeological sites located within 1 mile of DAEC (Louis Berger Group, Inc. 2008).

The earliest evidence for people in Iowa dates to the Paleo Indian period (11,500 B.C. to 8500 B.C.). The Paleo Indian period occurred as the ice sheets that once covered North America were retreating. Climate during the Paleo Indian period was much cooler and wetter than today. Paleo Indians lived a nomadic lifestyle focused on hunting large game. Fluted spear points are the most common artifact found associated with the Paleo Indian cultures such as Clovis or Folsom. Most Paleo Indian finds in Iowa consist of surface finds of isolated projectile points (Alex, 2000).

The Archaic Period (8500 B.C. to 800 B.C.) is defined by changes in technology from primarily large fluted points to smaller spear and dart points and grinding stones for processing plants. The intensification of resource use is seen as the result of increased population. During the Archaic period the land cover transformed from wooded to the tall grass prairie of today. The transformation took most of the 7,700 years encompassed by the period and spread from west to east. The very long Archaic Period is commonly divided into an Early (8500 B.C to 5500 B.C.), Middle (5500 B.C. to 3000 B.C.) and Late Period (3000 B.C. to 800 B.C.). Climate during the Archaic Period underwent significant alterations with the Middle Period being extremely dry. Changes in technology accelerated during the Archaic Period. Projectile point types proliferate during the Archaic Period. The atlatl, a notched wood stick which increases the throwing velocity of a spear, became widespread and the first evidence of dogs being kept also comes from the Archaic Period.

The Woodland Period is often divided into an Early (800 B.C. to 200 B.C.), Middle (200 B.C. to A.D. 300), and Late (A.D. 300 to A.D. 1250). Hallmarks of the Woodland Period are pottery, the burial mound, and horticulture mainly involving corn. The change to horticulture in the Late Woodland Period resulted in several changes to Native American societies. A horticultural tradition allows for a more predictable food supply but ties a population to specific locations. Burial mounds are a visible remnant of the Woodland Period. There are two types of mounds: burial and effigy. Large numbers of mounds and mound groups are found throughout the Midwest.

The final prehistoric period known near the project area is the Oneota (c. A. D. 1250 to 1700s). The Oneota relied on an agriculture based on corn, beans, and squash as well as seasonal hunting of small and large game and seasonal plant harvesting. Pottery styles and distinctive stone tools are hallmarks of the culture. Oneota sites usually contain numerous storage pits, multiple structures which can be of various construction types, and show evidence of reoccupation over time. Carved catlinite pipes and tablets are also indicative of Oneota culture.

When the first Europeans entered Iowa, there were roughly 18 distinct groups living in the state. These groups were the Ioway, Oto, Winnebago, Omaha, Ottawa, Huron, Miami, Kitchigami, Mascouten, Chippewa, Sauk, Mequaki, Potowatomi, Pawnee, Santee, Yankton, Moingwena, and Peoria (Alex, 2000). Many of these groups were originally from the eastern states and Canada but had been removed to the West in the face of European expansion. Through a series of treaties and constant Euro-American settlement, most Native Americans were removed from Iowa by the middle of the 19^{th} century. The only group that retains any land in the State is the Meskwakie. It is recognized by the Federal government as the Sac and Fox Tribe of the Mississippi in Iowa.

The first historic contact between Native Americans and Europeans within modern Iowa was when Father Jacques Marquette and Louis Joliet traveled down the Mississippi in 1673 (Schweider, 2009). In 1832, a group of Sauk Indians under Black Hawk resisted removal from northern Illinois. The group was eventually removed by mid-1832 in what was called the Black Hawk War. The Black Hawk Treaty of 1832, which ended the resistance, ceded the eastern portion of Iowa to Euro-American settlement. Linn County was created in 1837 as part of the Territory of Wisconsin. The county seat for Linn County is Marion. The first settler in Linn county arrived in 1839 (Brewer and Wick, 1911). Iowa became a State in December 1846, and railroads began crossing the State in the 1850s. With the coming of the railroads, Iowa became connected to the markets in Chicago. The primary products produced in Linn County were cattle and dairy products. By 1870 there were five railroad lines that crossed Iowa.

The area near the DAEC was originally settled as farmland. The first farmers grew corn and wheat and conducted subsistence farming. Some pigs and sheep were raised. Maple sugaring was also common, following the practices established by Native Americans. The town of Palo was established in 1854 (Rogers and Page, 1993). The town contained a blacksmith and sawmill. The economy of the region changed to cattle and dairying by the 1870s. During the twentieth century many of the farms were consolidated under large landowners. The consolidation of farm land continues to present. Another industry occurring in the vicinity of Palo was limestone quarrying. There were eight quarries operating near Palo in the 1960s.

2.2.9.2 *Historic and Archaeological Resources*

Four archaeological sites are known to exist on the DAEC property. The sites 13LN362, 13LN363, 13LN365, and 13LN366 were first identified in 1993 during a survey of the region (Rogers and Page, 1993). All four sites date to the late 19th century and are the remains of farmsteads. All but 13LN362 were recommended eligible for listing on the National Register of Historic Places. A 2008 archival study of the DAEC property identified 5 locations that have the potential to contain archaeological remains. The locations are associated with historic era farmsteads and a platted town site that appear on historic maps of the area (Louis Berger Group, Inc. 2008). The locations identified in the report have not been investigated; therefore, it remains unknown if subsurface remains exist.

Site 13LN362 is an artifact scatter associated with J. Craya who was reported as living in the location in 1859. There is some discrepancy in the location of the artifacts and the reported farm location (Louis Berger Group, Inc. 2008).

Site 13LN363 is the remains of a farmstead originally belonging to a John H. Ray. The farmstead first appears on an 1875 map of Linn County. The farm also appears on maps from 1907 and 1921 but was then associated with a Jonathon McClintock. The site does not appear on 1934 aerial photographs. A limestone foundation is still visible at the site.

Site 13LN365 is a farmstead that is first associated with a Sarah McClintock in 1895. The farmstead appears on later maps (1907, 1914, and 1921) associated with Jonathan McClintock. The site, consisting of nine structures, appears in aerial photographs from 1934 and 1939. The nine structures also appear in a 1970 aerial photograph. The structures had been removed by the 1980s. No surface features were noted at the site in 1993.

The final known site on the DAEC property is 13LN366. The site consists of a historic artifact scatter. No farms or structures appear in this location on any historic maps or aerial photographs of the region.

<u>Transmission Lines</u>

There are roughly 101 miles of transmission line associated with the DAEC (FPL-DA, 2008a) (see Figure 2-7). A review of files at the Iowa Office of the State Archaeologist identified that there are 12 archaeological sites located in the ROW of the transmission lines associated with DAEC. The archaeological sites are listed in Table 2-16. Because the transmission lines were constructed prior to passage of the National Historic Preservation Act (NHPA), no historic and archaeological surveys were undertaken for the transmission lines. The resources listed were identified through surveys conducted for various highway projects and Section 106 compliance projects. The transmission lines are owned and maintained by ITC Midwest, LLC.

Table 2-16. Historic and Archaeological Sites in the Duane Arnold Energy Center Associated Transmission Lines

Site Name	Cultural Affiliation	NRHP Status
13LN81	Prehistoric	Unevaluated
13LN88	Woodland	Unevaluated
13LN139	Prehistoric/Historic	Unevaluated
13LN141	Prehistoric	Unevaluated
13LN167	Prehistoric	Unevaluated
13LN173	Prehistoric	Unevaluated
13LN183	Prehistoric	Unevaluated
13LN228	Prehistoric	Unevaluated
13LN362	Historic	Unevaluated
13LN380	Historic	Unevaluated
13LN465	Prehistoric	Unevaluated
13LN810	Historic	Unevaluated

2.3 RELATED FEDERAL AND STATE ACTIVITIES

The staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the operating license for DAEC. Any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of the DAEC SEIS.

There are no known Federal facilities within 50 miles of DAEC. The staff has determined that there are no Federal projects that would make it desirable for another Federal agency to become a cooperating agency in the preparation of the SEIS. Parks and wilderness areas located near the DAEC are listed below:

- Pleasant Creek State Recreation Area
- Palo Marsh Wildlife Refuge
- Wickiup Hill Outdoor Learning Area

NRC is required under Section 102(2)(c) of the NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. NRC has consulted with the American Council on Historic Preservation and the USFWS. Federal Agency consultation correspondence and comments on the SEIS are presented in Appendix D.

2.4 REFERENCES

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

CFR. "Licensing Requirements for Land Disposal of Radioactive Waste," Part 61, Title 10, "Energy."

CFR. "Packaging and Transportation of Radioactive Material," Part 71, Title 10, "Energy."

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

License renewal actions include refurbishment actions for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. If such actions were planned, the potential environmental effects of refurbishment actions would be identified and the analysis would be summarized within this section.

Environmental issues associated with refurbishment activities are discussed in the "Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants", NUREG-1437, Vol. 1 and 2 (U.S. Nuclear Regulatory Commission (NRC) 1996, 1999).[1] The GEIS includes a determination of whether or not the analysis of the environmental issues can be applied to all plants and whether or not additional mitigation measures are warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system, or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this supplemental environmental impact statement (SEIS) unless new and significant information is identified. Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, an additional plant-specific review of these issues is required. Environmental issues associated with refurbishment, which were determined to be Category 1 and Category 2 issues, are listed in Tables 3-1 and 3-2, respectively.

Requirements for the renewal of operating licenses for nuclear power plants include the preparation of an integrated plant assessment (IPA) pursuant to Section 54.21 of Title 10 of the Code of Federal Regulations (CFR). The IPA must identify and list systems, structures, and components subject to an aging management review. The GEIS (NRC, 1996) provides helpful information on the scope and preparation of refurbishment activities to be evaluated. Environmental resource categories to be evaluated for impacts of refurbishment include terrestrial resources, threatened and endangered species, air quality, housing, public utilities and water supply, education, land use, transportation, and historic and archaeological resources. Items that are subject to aging and might require refurbishment include, for example,

1 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.

the reactor vessel piping, supports, and pump casings (see 10 CFR 54.21 for details), as well as items that are not subject to periodic replacement.

FPL Energy Duane Arnold, LLC (FPL-DA) performed an IPA on Duane Arnold Energy Center (DAEC) pursuant to 10 CFR 54.21. This assessment did not identify the need to undertake any major refurbishment or replacement actions to maintain the functionality of important systems, structures, and components during the DAEC license renewal period or other facility modifications associated with license renewal that would affect the environment or plant effluents (FPL-DA, 2008); therefore, an assessment of refurbishment activities is not considered in this SEIS.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
Groundwater Use and Quality	
Impacts of refurbishment on groundwater use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
Terrestrial Resources		
Refurbishment impacts	3.6	E
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	3.9	E
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
Socioeconomics		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
Environmental Justice		
Environmental justice	Not addressed[a]	Not addressed[a]

[a] Guidance related to environmental justice was not in place at the time the NRC prepared the GEIS and the associated revision to 10 CFR Part 51. If an applicant plans to undertake refurbishment activities for license renewal, the applicant's ER and NRC staff's environmental impact statement must address environmental justice.

3.1 REFERENCES

CFR (*U.S. Code of Federal Regulations).* "*Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*," Part 51, Title 10, "Energy." NUREG-1437, Supplement 33 3-4 August 2008.

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NRC. *Generic Environmental Impact Statement for License Renewal of Nuclear Plant*. NUREG-1437, Vol. 1, Add. 1, Office of Nuclear Reactor Regulation, Washington, DC, 1999.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

Chapter 4 investigates potential environmental impacts related to the period of extended operation of Duane Arnold Energy Center (DAEC). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis provided in the *Generic Environmental Impact Statements (GEIS) for License Renewal of Nuclear Power Plants* prepared by the U.S. Nuclear Regulatory Commission (NRC) and are discussed briefly (NRC 1996, 1999a). The NRC staff (Staff) has also analyzed site-specific issues (Category 2) for DAEC and assigned them a significance level (e.g., SMALL, MODERATE, or LARGE). Some remaining site characteristics or plant feature issues are not applicable to DAEC. Section 1.4 of this report explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE. The issue of waste management is dealt with in Chapter 6.

4.1 LAND USE

Land use issues are listed in Table 4-1. The Staff did not identify any Category 2 issues for onsite land use and did not identify any new and significant information during the review of the environmental report (ER) (FPL Energy Duane Arnold, LLC (FPL-DA), 2008a), the site audit, or the public scoping process; therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 2 issues, the GEIS concludes that the impacts are designated as SMALL, and additional site-specific mitigation measures are unlikely to be warranted.

Table 4-1. Category 1 Issues Applicable to Onsite Land Use during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
Onsite land use	
Onsite land use	4.5.3.1
Power line right-of-way	4.5.3.1

4.2 AIR QUALITY

Table 4-2 lists the air quality issue applicable to DAEC. The Staff did not identify any Category 2 issues for air quality. The Staff also did not identify any new and significant information during the review of the applicant's ER (FPL-DA, 2008a), the site audit, or the scoping process; therefore, there are no impacts related to this issue beyond those discussed in the GEIS. Consistent with the GEIS, the staff therefore concludes that the impacts are SMALL, and additional site-specific mitigation measures are unlikely to be warranted.

Table 4-2. Air Quality Issue. *Section 2.2.2 of this report describes air quality in the vicinity of DAEC.*

Issue	GEIS Section	Category
Air quality effects of transmission lines	4.5.2	1

4.3 GROUNDWATER

The Category 2 groundwater issues applicable to the DAEC are discussed below and listed in Table 4-3. No Category 1 issues relate to the site.

Table 4-3. Groundwater Use and Quality Issues. *Groundwater use and quality at the DAEC are discussed in Section 2.2.3.*

Issues	GEIS Sections	Category
Groundwater use conflicts (potable and service water, and dewatering plants that use >100 gpm)	4.8.1.1, 4.8.2.1	2
Groundwater use conflicts (plants using cooling towers withdrawing makeup water from a small river)	4.8.1.3, 4.4.2.1	2

4.3.1 Generic Groundwater Issues

Discussions during the site audit included description of various incidents, including a diesel line break and cleanup and several sulphuric acid tank leaks, which were contained. During the most recent dredging, a few gallons of diesel fuel were spilled into the Cedar River. Cleanup was directed toward removing the sheen at the surface of a backwater (water backed up in its course by an obstruction). In 1983, a barrel of 30 gal (114 L) of condensate water was spilled and flowed into the storm sewer (FPL-DA, 2006c). The site maintains that “there have been no identified instances of radioactivity released from the DAEC that resulted in groundwater concentrations exceeding the allowable Environmental Protection Agency (EPA) maximum contaminant levels for drinking water” (FPL-DA, 2006c).

The National Pollutant Discharge Elimination System (NPDES) application (FPL-DA, 2008c) describes several releases in the prior three years. These include a July 2006 sulphuric acid tank leak of approximately 1,000 gal (3,800 L) into a concrete containment berm. Only a few gallons were not contained. In September 2007, some petroleum-contaminated soil was discovered beneath a concrete structure. The soil was excavated and disposed of.

The potential impact to groundwater from the incidents described above is considered low because of the volume and type of contaminants and the mitigation measures taken in each instance. The Staff did not identify any new and significant information regarding Category 1 issues during the review of DAEC’s ER (FPL-DA, 2008a), the site audit, or during the public scoping process. The Staff also evaluated and reviewed various permits, assorted applicant files, radiological environmental monitoring program (REMP) reports, and other sources of information; therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted.

4.3.2 Groundwater Use Conflicts (Plants That Use More Than 100 Gallons [378 Liter] Per Minute)

NRC specifies as issue #33 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that, “if the applicant’s plant…pumps more than 100 gallons (total onsite) of groundwater per minute (gpm), an assessment of the impact of the proposed action on groundwater use must be provided.” NRC further states that “plants that use more than 100 gpm (378 L) of groundwater may cause groundwater use conflicts with nearby groundwater users,” (10 CFR 51.53[c][3][ii][C]). This applies to DAEC because, as discussed in Section 2.1.7.1 of this report, DAEC uses over 1,500 gpm (5,700 liter per minute) of groundwater.

The DAEC pumps groundwater from four production wells on a schedule that normally involves one or two wells pumping at a time. Approximately 100 gpm (378 liter per minute) of groundwater are used for demineralizer makeup, less than 10 gpm (38 liter per minute) are used for potable supply, and about 1,400 gpm (5,300 liter per minute) are sent to an air cooling system.

A drawdown test was performed in 1972 (Bechtel Corp., 1972), which involved increasing the pumping rate at well No. 1, turning on well No. 2, and measuring drawdown at five observation wells. Although drawdown was minimal at most of the observation well locations, the locations and depths of the various pumping wells and observation wells are not described in Bechtel's test results, so the Staff cannot evaluate the results.

In 2001, an aquifer test at Well A showed a stable water level in the well after five hours of pumping at 930 gpm (3,500 liter per minute) (Northway Well and Pump Co., 2001). More importantly, recent water level data from a set of six monitoring well nests (FPL-DA, 2007b) do not show a cone of depression at the site. Concerns about water supply are not known from nearby private well owners. Annual withdrawal volumes have remained fairly steady and are approximately one-half of the permitted amount (IDNR, 2005). Therefore, the Staff concludes the impact on groundwater from pumping more than 100 gpm is SMALL.

4.3.3 Groundwater Use Conflicts (Makeup from a Small River)

NRC specifies that, “if the applicant’s plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river whose annual flow rate is less than 3.15×10^{12} cubic feet per year (ft^3/year) (99,885 cubic feet per second (cfs))…[t]he applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow,” (10 CFR 51.53[c][3][ii][A]). For water use conflicts, NRC further states, as issue #34 in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that, “water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come online before the time of license renewal….” This issue is applicable to DAEC because the water used for the plant cooling towers is withdrawn from the Cedar River, which has an annual mean flow of approximately 1.2×10^{11} ft^3/yr (3,878 cfs or 110 m^3/s), thus meeting NRC’s definition of a small river. Flow is monitored in Cedar Rapids, IA, about 15 miles (24 km) downstream of DAEC.

The Cedar River has an average flow of 3,878 cfs (110 m^3/s) at Cedar Rapids. Flow at DAEC is expected to be similar because no major tributaries enter the river between the facility and Cedar Rapids. The design rate for water withdrawal under operating conditions is 11,200 gpm (25 cfs or 0.71 m^3/s), or approximately 0.6 percent of the average river flow. Maximum consumptive use is 8,100 (18 cfs or 0.51 m^3/s), or approximately 0.46 percent of the average river flow.

During low-flow periods, the withdrawal rate and consumptive rate are higher proportions of the river flow. By permit, when river flow falls below 500 cfs (14 m^3/s), the Pleasant Creek Recreational Reservoir may discharge to the Cedar River at a rate equal to the consumptive use rate (IDNR, 2005). At this low-flow threshold, flow in the river is only 13 percent of the average flow, the withdrawal rate is 5 percent of the low flow, and the return of blowdown to the river results in a net consumptive rate of over 3 percent of the low flow. Discharge from the reservoir is not a requirement of the permit.

In summary, the withdrawal is typically less than 1 percent of river flow and the release of water from a reservoir is possible during drought. In the vicinity of the plant, private wells do not pump from the alluvium layer. The Staff concludes that the impact on groundwater due to the use of a small river for makeup water purposes is SMALL.

4.4 SURFACE WATER

Surface water quality issues applicable to DAEC are discussed below and listed in Table 4-4. The Staff did not identify any new and significant information during the review of DAEC's ER (FPL-DA, 2008a), the site audit, or during the public scoping process. The Staff reviewed other sources of information such as various permits, a permit application, assorted applicant files, and REMP reports, and concludes there are no impacts related to these issues beyond those discussed in the GEIS. For surface water issues, the GEIS concluded that the Category 1 issues were SMALL, and additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted.

Table 4-4. Surface Water Quality Issues. *A description of the surface water quality conditions at DAEC is provided in Section 2.2.4.*

Issues	GEIS Sections	Category
Altered current patterns at intake and discharge structures	4.2.1.2.1	1
Altered salinity gradient	4.2.1.2.2	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1
Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	4.3.2.1, 4.4.2.1	2

4.4.1 Water Use Conflicts

Section 4.3.3 describes NRC's requirements for assessing water use conflicts on a "small river" Specifically. NRC specifies that, "if the applicant's plant uses cooling towers or cooling ponds and withdraws makeup water from a river whose annual flow rate is less than 3.15 x 10^{12} ft^3/year (99,885 cfs or 2,828 m^3/s), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided" (10 CFR 51.53(c)(3)(ii)(A)). For water use conflicts, NRC further states as issue #13 in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, that "[t]he issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of MODERATE significance in some situations."

This issue is applicable to DAEC because the plant uses a cooling-tower-based heat dissipation system, and water to replace that lost to evaporation in the cooling system is withdrawn from the Cedar River (which has an annual mean flow of approximately 1.2 x 10^{11} ft^3/yr (3,878 cfs or 110 m^3/s), meeting NRC's definition of a small river). Flow is monitored in Cedar Rapids, IA, about 15 mi (24 km) downstream of DAEC. The GEIS considered surface water use conflicts to be a Category 2 issue for two reasons:

(1) Consumptive water use can adversely affect riparian vegetation and instream aquatic communities. Reducing the amount of water available to either the riparian zones or instream communities could result in impacts on threatened and endangered species, wildlife, and recreational uses of the water body. In addition, riparian vegetation performs several important ecological functions, including stabilizing channels and floodplains, influencing water temperature and quality, and providing habitat for aquatic and terrestrial wildlife.

(2) Continuing operation of these facilities depends on the availability of water within the river from which they are withdrawing water. For facilities that are located on small bodies of water, the volume of available water is expected to be susceptible to droughts and to competing water uses within the basin. In cases of extreme drought, these facilities may be required to curtail operations if the volume of water available is not sufficient.

An additional effect of the withdrawal of water from a small river is that the withdrawal may have an impact on groundwater levels, which would result in groundwater use conflicts (NRC, 1996). The Staff considers this to be a separate Category 2 issue, which is evaluated in Section 4.3.3 of this draft SEIS.

As discussed in Section 2.1.7.2, flow in the Cedar River at Cedar Rapids averages 3,878 cfs (110 m^3/s). Flow at DAEC is expected to be similar because no major tributaries enter the river between the facility and Cedar Rapids. The design rate for water withdrawal under operating conditions is 11,200 gpm (25 cfs or 0.71 m^3/s), or approximately 0.6 percent of the average river flow. Maximum consumptive use is 8,100 gpm (18 cfs), or approximately 0.46 percent of the average river flow.

During low-flow periods, the withdrawal rate and consumptive rate are higher proportions of the river flow. By permit, when river flow falls below 500 cfs, the Pleasant Creek Recreational Reservoir may discharge to the Cedar River at a rate equal to the consumptive use rate (IDNR, 2005). At this low-flow threshold, flow in the river is only 13 percent of the average flow, the withdrawal rate is 5 percent of the low flow, and the return of blowdown to the river results in a net consumptive rate of over 3 percent of the low flow. Discharge from the reservoir is not a requirement of the permit. During low-flow conditions, the effect would be magnified and could contribute to a cumulative impact.

In summary, the withdrawal is typically less than 1 percent of mean river flow and the release of water from a reservoir is possible during drought. However, during a period of low river flow associated with a drought, the withdrawal rate may be significant. The Staff concludes the impact on groundwater due to the use of a small amount of river makeup water is SMALL to MODERATE.

4.5 AQUATIC RESOURCES

Table 4-5 lists issues related to aquatic resources applicable to DAEC. No Category 2 issues are related to aquatic resources. The Staff did not find any new and significant information during the review of the applicant’s ER, the site audit, the scoping process, or the evaluation of other available information; therefore, the Staff concludes that there are no impacts related to aquatic resource issues beyond those discussed in the GEIS (NRC, 1996). Consistent with the GEIS, the Staff concludes that the impacts are SMALL, and additional site-specific mitigation measures are unikely to be sufficiently beneficial to warrant implementation.

Table 4-5. Aquatic Resource Issues. *Section 2.1.6 of this report describes the DAEC cooling water system; Section 2.2.5 describes aquatic resources.*

Issues	GEIS Section	Category
For All Plants		
Accumulation of contaminants in sediments or biota	4.2.1.2.4	1
Entrainment of phytoplankton and zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
For Plants with Cooling Tower-Based Heat Dissipation Systems		
Entrainment of fish and shellfish in early life stages	4.3.3	1
Impingement of fish and shellfish	4.3.3	1
Heat shock	4.3.3	1

4.6 TERRESTRIAL RESOURCES

The issues related to terrestrial resources applicable to DAEC are listed in Table 4-6. There are no Category 2 issues related to terrestrial resources. NRC did not identify any new and significant information during the review of the applicant's ER, the Staff's site audit, the scoping process, or the evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. Consistent with the GEIS, the Staff concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-6. Terrestrial Resources Issues. *Section 2.2.6 provides a description of the terrestrial resources at DAEC and in the surrounding area.*

Issues	GEIS Section	Category
Cooling tower impacts on crops and ornamental vegetation	4.3.4	1
Cooling tower impacts on native plants	4.3.5.1	1
Bird collisions with cooling towers	4.3.5.2	1
Power line right-of-way management (cutting herbicide application)	4.5.6.1	1
Bird collisions with power lines	4.5.6.1	1
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains and wetlands on power line right-of-way	4.5.7	1

4.7 THREATENED AND ENDANGERED SPECIES

The issues related to terrestrial resources applicable to DAEC are listed in Table 4-7.

Table 4-7. Threatened or Endangered Species. *Section 2.2.7 describes the threatened or endangered species on or near DAEC.*

Issue	GEIS Section	Category
Threatened or endangered species	4.1	2

This site-specific, or Category 2 issue, requires consultation with the appropriate agencies to determine whether or not threatened or endangered species are present and whether or not they would be adversely affected by continued operation of DAEC during the license renewal term. The characteristics and habitats of threatened and endangered species in the vicinity of the DAEC site are discussed in Sections 2.2.5 through 2.2.7 of this draft SEIS.

NRC contacted the U.S. Fish and Wildlife Service (USFWS) on May 6, 2009, regarding threatened and endangered species at the DAEC site (NRC, 2009a). A description of the site and the in-scope transmission lines and a preliminary assessment of the Federal threatened, endangered, and candidate species potentially occurring on or near the DAEC site was provided in this letter. In response, on May 29, 2009, the USFWS indicated that the prairie bush clover (*Lespedeza leptostachya*) and the western prairie fringed orchid (*Platanthera praeclara*), both listed as threatened on Federal and Iowa State lists have the potential to occur in Linn

County (USFWS, 2009). Neither species was identified during the pre-operational terrestrial flora study (Neimann and McDonald, 1972), nor have they been identified on the DAEC site since this time (FPL-DA, 2008a).

NRC contacted the Iowa Department of Natural Resources (IDNR) on May 6, 2009, to request data to aid in determining which State-listed species may be affected by continued operations and maintenance procedures at the DAEC site and associated transmission line right of ways (ROWs) (NRC, 2009b). The IDNR provided responses on May 18, 2009, indicating that its record search for rare species and significant natural habitats or communities yielded "no site-specific records that would be impacted by the use of existing plant facilities and transmission lines" (IDNR, 2009a).

4.7.1 Aquatic Species

The Staff has reviewed information provided by the applicant and information publicly available and has contacted the USFWS and IDNR (NRC 2009a, 2009b). Currently, no threatened or endangered aquatic species are known to occur within the Cedar River near the vicinity of DAEC or within any streams crossed by in-scope transmission line ROWs. Therefore, license renewal of DAEC would have no effect on any Federally or State-listed aquatic species, and mitigation measures do not need to be considered.

4.7.2 Terrestrial Species

Currently, no known sightings of Federally listed threatened or endangered terrestrial species have occurred on the DAEC site or within the in-scope transmission line ROWs. Operation of DAEC and its associated transmission lines are not expected to adversely affect any threatened or endangered terrestrial species during the license renewal term.

The Staff encourages FPL-DA and Information Technology Council (ITC) Midwest LLC to identify and report the existence of any Federally or State-listed endangered or threatened species within or near the transmission line ROWs to the IDNR and/or USFWS if any such species are identified during the renewal term. In particular, if any evidence of injury or mortality of migratory birds or threatened or endangered species is observed within transmission line ROWs during the renewal period, FPL-DA or ITC is encouraged to report this information promptly to the appropriate wildlife management agencies.

4.8 HUMAN HEALTH

The human health issues applicable to DAEC are discussed below and listed in Table 4-8 for Category 1, Category 2, and uncategorized issues.

Table 4-8. Human Health Issues. *Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains additional information on human health issues applicable to DAEC.*

Issues	GEIS Section	Category
Microbiological organisms (occupational health)	4.3.6	1

Issues	GEIS Section	Category
Microbiological organisms (public health, for plants using small rivers)	4.3.6	2
Noise	4.3.7	1
Radiation exposures to public (license renewal term)	4.6.1, 4.6.2	1
Occupation radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields – acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields – chronic effects	4.5.4.2	Uncategorized

4.8.1 Generic Human Health Issues

The Staff did not identify any new and significant information during its review of the FPL-DA ER, the site audit, or the public scoping process; therefore, there are no impacts related to generic human health issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted. The information presented below discusses selected radiological programs conducted at DAEC.

DAEC conducts a REMP to assess the radiological impact, if any, to its employees, the public, and environs around the plant site. An annual radiological environmental operating report is issued with a discussion of the results of the monitoring program. The report contains data on the monitoring performed for the most recent year and graphs, which show data trends from prior years, and in some cases, provide a comparison to pre-plant operation baseline data. The objectives of the REMP include the following:

- To measure and evaluate the levels of radiation and radioactive material in the environs around the DAEC site to assess the radiological impacts, if any, of plant operation on the environment.
- To supplement the results of the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive material and levels of radiation are not higher than expected based on the measurement of radioactive effluents and modeling for the applicable exposure pathways.
- To demonstrate compliance with the requirements of applicable Federal regulatory agencies.

The DAEC REMP collects samples of environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The media samples are representative of radiation exposure pathways to the public from all plant radioactive effluents. The REMP measures the aquatic, terrestrial, and atmospheric environment, as well as ambient gamma radiation, for radioactivity. Ambient gamma radiation pathways include radiation from buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Thermoluminescent dosimeters

(TLDs) are used to measure direct radiation. Atmospheric environmental monitoring consists of sampling the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of milk and food products. Aquatic environmental monitoring consists of analyzing samples of surface water, drinking water, groundwater, fish, and sediment from the Cedar River. There is also an onsite groundwater protection program designed to monitor the onsite plant environment for early detection of leaks from plant systems and pipes which convey radioactive liquids.

The Staff reviewed the DAEC annual radiological environmental operating reports for 2004 through 2008 to identify any significant impacts to the environment or any unusual trends in the data (FPL-DA 2005c, 2006d, 2007c, 2008d, 2009d). The Staff's review of the REMP reports revealed no unusual trends in the data and showed no measurable impact from the operations at DAEC on the environment. Further, NRC inspection reports were also reviewed supporting this conclusion.

Historical data on radioactive releases from DAEC and the resultant dose calculations demonstrate that the amount of radiation received to a hypothetical maximally exposed individual in the vicinity of DAEC is a small fraction of the dose limits specified in 10 CFR Part 20–the "as low as is reasonably achievable" (ALARA) dose design objectives in Appendix I to 10 CFR Part 50, and EPA's radiation standards in 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." Dose estimates for members of the public are calculated based on liquid and gaseous effluent release data and atmospheric and aquatic transport models. The DAEC 2008 annual radioactive material release report (FPL-DA, 2009c) contains a detailed presentation of the radioactive discharges and the resultant calculated doses. The following conclusion summarizes the calculated hypothetical maximum dose to an individual located outside the DAEC site boundary from radioactive liquid and gaseous effluents released during 2007:

- The maximum whole-body dose to an offsite member of the public from liquid effluents discharged from the sanitary waste treatment facility was 3.23 E-05 milliroentgen equivalent man (mrem) (3.23 E-07 millisievert (mSv)), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ (child liver) dose to an offsite member of the public from liquid effluents discharged from the sanitary waste treatment facility effluents was 3.23 E-05 mrem (3.23 E-07 mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum air dose at the site boundary from gamma radiation in gaseous effluents was 4.96 E-04 milliradiation absorbed dose (mrad) (4.96 E-06 milligray (mGy)), which is well below the 10 mrad (0.1 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum air dose at the site boundary from beta radiation in gaseous effluents was 1.01 E-04 mrad (1.01 E-06 mGy), which is well below the 20 mrad (0.2 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ (child liver) dose to an offsite member of the public from radioactive iodine and radioactive material in particulate form was 1.13 E-02 mrem (1.13 E-04 mSv), which is well below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Based on the Staff's review and assessment of the DAEC radioactive waste system performance in controlling radioactive effluents and the resultant doses to members of the public in conformance with the ALARA criteria, the Staff found that the 2008 radiological effluent data for DAEC are consistent, with reasonable variation attributable to operating conditions and outages, with the five-year historical radiological effluent releases and resultant doses (FPL-DA 2005d, 2006e, 2007d, 2008e, 2009e). These results demonstrate that DAEC is operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50 and 10 CFR Part 20.

The applicant has no plans to conduct refurbishment activities during the license renewal term, thus, no significant change to radiological conditions is expected to occur. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents are not expected to change during the license renewal term.

4.8.2 Microbiological Organisms – Public Health

The effects of thermophilic microbiological organisms on human health, listed in Table B-1 of Appendix to Subpart A of 10 CFR Part 51, are categorized as a Category 2 issue and require a plant-specific evaluation during the license renewal process for the plants located on the small river that use closed-cycle cooling. The average annual flow of the Cedar River nearest the DAEC measuring station is approximately 1.05 x 10^{11} ft^3/yr (2.97 x 10^9 m^3/yr) to 1.19 x 10^{11} ft^3/yr (3.37 x 10^9 m^3/yr), which is less than the threshold value of 3.15 x 10^{12} ft^3/yr (9 x 10^{10} m^3/yr) in 10 CFR 51.53(c)(3)(ii)(G) for thermal discharge to a small river (FPL-DA, 2008a). Therefore, the effects of the DAEC cooling water discharge on microbiological organisms must be addressed for DAEC license renewal.

The Category 2 designation is based on the magnitude of the potential public health impacts associated with thermal enhancement of enteric pathogens such as *Salmonella* spp. and *Shigella* spp., the *Pseudomonas aeruginosa* bacterium, the pathogenic strain of the free-living amoebae *Naegleria* spp., and *Legionella* spp. bacteria (NRC, 1996). Thermophilic microorganisms generally occur at temperatures of 77°F to 176°F (25°C to 80°C) with optimal growth temperature range of 122°F to 150°F (50° to 66°C), and minimum and maximum temperature tolerances of 68°F (20°C) and 158°F (70°C), respectively; however, thermal preferences and tolerances vary across bacterial groups. Pathogenic thermophilic microbiological organisms of concern during nuclear reactor operation typically have optimal growing temperatures of approximately 99°F (37°C) (Joklik and Smith, 1972).

Pseudomonas aeruginosa is an opportunistic pathogen that causes serious and sometimes fatal infections in immunocompromised individuals. The organism produces toxins harmful to humans and animals. It has an optimal growth temperature of 99°F (37°C) (Todar, 2007). *Legionella* spp. consists of at least 46 species and 70 serogroups. It is responsible for Legionnaires' disease, with the onset of pneumonia in the first two weeks of exposure. Risk groups for *Legionella* spp. include elderly, cigarette smokers, persons with chronic lung or immunocompromising disease, and persons receiving immunosuppressive drugs.

The ambient temperatures of the Cedar River near DAEC varies from freezing (32°F (0°C)) in the winter to 76°F–78°F (24.4°C–25.6°C) in the summer. Therefore, ambient river conditions are not likely to support the proliferation of the pathogenic organisms of concern. Table 4-9 represents the maximum daily discharge temperatures at outfall 001, reported in DAEC NPDES monthly reports for the 2001–2008 period.

Table 4-9. The Maximum Daily Discharge Temperatures, Reported in DAEC NPDES Reports for the 2001-2008 Period

Date (month/year)	Maximum Daily Discharge Temperature
July, August 2001	89°F (31.7°C)
June, July 2002	90°F (32.2°C)
July 2003	89°F (31.7°C)
July, August 2004	89°F (31.7°C)
June, August 2005	88°F (31.1°C)
July 2006	80°F (26.7°C)
July, August 2007	78°F (25.6°C)
August 2008	79°F (26.1°C)

The highest daily discharge temperature reported at DAEC in the 2001–2008 period is 90°F (32.2°C) during June and July of 2002, which is below the optimal growing temperature of approximately 99°F (37°C) for the pathogenic thermophilic microbiological organisms that are of concern during nuclear power reactor operation. DAEC implements additional measures (disinfection and chlorination of water discharged from DAEC) to control and inhibit the proliferation of the pathogenic thermophilic microbiological organisms (FPL-DA, 2008a). Ambient temperatures within the Cedar River are below 77°F (25°C) from October to April. Based on this data, ambient river conditions are not likely to support the proliferation of the pathogenic organisms of concern.

FPL-DA consulted the Bureau of Water Supply Management of the Iowa Department of Public Health (IDPH) to determine whether or not there was any concern about the possible occurrence of thermophilic microbiological organisms in the Cedar River at the DAEC location. IDPH stated that no occurrences of infections caused by *Naegleria fowleri* and *Legionella* from the Cedar River in the DAEC vicinity had been documented (FPL-DA, 2008a).

Available data assembled into biannual reports by the U.S. Centers for Disease Control (CDC) and Prevention for the years 1999 to 2006 (CDC 2000, 2002, 2004, 2006) indicates no occurrence of waterborne disease outbreaks in the State of Iowa resulting from exposure to the thermophilic microbiological organisms *Naegleria fowleri* and *Pseudomonas aeruginosa.*

The Staff reviewed all documents applicable to this Category 2 issue including the FPL-DA Environmental Report, the DAEC NPDES permit, and CDC reports. The Staff concludes that thermophilic microbiological organisms are unlikely to present a public health hazard as a result of DAEC discharges to the Cedar River. The Staff concludes that impacts on public health from thermophilic microbiological organisms from continued operation of DAEC in the license renewal period would be SMALL.

The Staff identified measures that could mitigate the potential impacts of thermophilic microbiological organisms resulting from continued operation of DAEC. These mitigation measures include periodically monitoring for thermophilic microbiological organisms in water and sediments near the discharge, as well as prohibiting recreational use near the discharge plume. These mitigation measures could reduce human health impacts by minimizing public exposure to thermophilic microbiological organisms. The Staff did not identify any cost-benefit studies applicable to the mitigation measures mentioned above.

4.8.3 Electromagnetic Fields – Acute Shock

Based on the GEIS, the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been a problem at most operating plants and generally are not expected to be a problem during the period of extended operation. However, a site-specific review is required to determine the significance of electric shock potential along the portions of the transmission lines within the scope of this draft SEIS.

The GEIS states that it is not possible to determine the significance of the electric shock potential without a review of the conformance of each nuclear plant's transmission lines with National Electrical Safety Code (NESC) (IEEE, 2007) criteria. An evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

All transmission lines associated with DAEC were constructed in accordance with NESC and industry guidance in effect at that time (AEC, 1973). Transmission lines and facilities are maintained to ensure continued compliance with current standards. A transmission line assessment program implemented at DAEC ensures for continued monitoring and documenting of the transmission line conditions, maintenance and compliance with existing standards. Routine aerial inspections are conducted every six months to identify any ground clearance problems and ensure integrity of the transmission line structures. Ground inspections are conducted biannually by transmission line technicians (FPL-DA, 2008a).

Since the lines were constructed, a new criterion has been added to the NESC for power lines with voltages exceeding 98 kilovolts (kV). FPL-DA has reviewed the transmission lines for compliance with this criterion (FPL-DA, 2008a). FPL-DA indicated that all transmission lines within the scope of this review have been restudied, and the results show there are no locations under the transmission lines that have capacity to induce more than 5 milliamperes (mA) in a vehicle parked beneath the line. No induced shock hazard to the public should occur since the lines are operating within original design specifications and meet current NESC clearance standards.

The Staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the Staff evaluated potential impacts for electric shock resulting from operation of DAEC and its associated transmission lines. The Staff concludes that the potential impacts from electric shock during the renewal period are SMALL.

The Staff identified measures that could mitigate potential acute electromagnetic force (EMF) impacts resulting from continued operation of the DAEC's transmission lines. These mitigation measures include erecting barriers along the length of the transmission lines to prevent unauthorized access to the ground beneath the conductors, and installing road signs at road crossings. These mitigation measures could reduce human health impacts by minimizing public exposures to electric shock hazards. The Staff did not identify any cost benefit studies applicable to the mitigation measures mentioned above.

4.8.4 Electromagnetic Fields – Chronic Effects

In the GEIS, the chronic effects of 60-herz (Hz) electromagnetic fields from power lines are not designated as Category 1 or 2, and will not be, until a scientific consensus is reached on the health implications of these fields.

The potential for chronic effects from these fields continues to be studied and is not known at this time. A 1999 report by the National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). The report by NIEHS contains the following conclusion, which is supported by recently published Environmental Health Criteria Monograph No.238 (WHO, 2007):

> ELF-EMF (extremely low frequency-electromagnetic field) 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 change its position with respect to the chronic effects of electromagnetic fields (10 CFR 51 Footnote 5 to Table B-1):

> If in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The Staff considers a GEIS finding of an "uncertain" hazard appropriate and will continue to follow developments on this issue.

4.9 SOCIOECONOMICS

Category 1 issues depicted in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, which are applicable to socioeconomic impacts during the renewal term are listed in Table 4-10. As stated in the GEIS, the impacts associated with these Category 1 issues are determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

The Staff reviewed and evaluated the DAEC ER, public scoping comments, other available information, and visited DAEC in search of new and significant information that could change the conclusions presented in the GEIS. No new and significant information was identified during this review. Therefore, it is expected that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

Table 4-10. Category 1 Issues Applicable to Socioeconomics during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

4.9.1 Generic Socioeconomic Issues

The results of the NRC review and brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues over the license renewal term are provided below:

Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found that: Impacts to public safety, social services, and tourism and recreation are expected to be of a significance level of SMALL at all sites.

Public services: education. Based on information in the GEIS, the Commission found that: Only impacts of a significance level of SMALL are expected.

Aesthetic impacts. Based on information in the GEIS, the Commission found that: No significant impacts are expected during the license renewal term

Aesthetic impacts of transmission lines. Based on information in the GEIS, the Commission found that: No significant impacts are expected during the license renewal term

No new and significant information was identified for these issues during the review. Therefore, no impacts are expected during the renewal term beyond those discussed in the GEIS.

Table 4-11 lists the Category 2 socioeconomic issues that require plant-specific analysis and an environmental justice impact assessment, which was not addressed in the GEIS.

Table 4-11. Category 2 Issues Applicable to Socioeconomics and Environmental Justice during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
Socioeconomics			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services: transportation	4.7.3.2	J	4.4.4
Historic and archaeological resources	4.7.7	K	4.4.5
Environmental justice	Not addressed[a]	Not addressed[a]	4.4.6

[a] Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared; therefore, environmental justice must be addressed in plant-specific reviews.

4.9.2 Housing Impacts

Appendix C of the GEIS presents a population characterization method based on two factors: sparseness and proximity (NRC, Section C.1.4, 1996). Sparseness measures population density within 20 miles of the site, and proximity measures population density and city size within 50 miles of the site. Each factor has categories of density and size (NRC, Table C.1, 1996). A matrix is used to rank the population category as low, medium, or high (NRC, Figure C.1, 1996).

In 2000, approximately 210,081 persons lived within a 32-km (20-mi) radius of DAEC, which equates to a population density of 167 persons per mi^2. This density translates to a Category 4 (greater than or equal to 120 persons per mi^2 within 20miles) using the GEIS measure of sparseness (FPL-DA, 2008a). At the same time, there were approximately 621,461 persons living within a 50-mi radius of the plant, for a density of 79 persons per mi^2, meaning that DAEC falls into Category 3 (one or more cities with 100,000 or more persons and less than 190 persons per mi^2 within 50miles (80 km) on the NRC proximity scale. A Category 4 value for sparseness and a Category 3 value for proximity indicate that DAEC is in a high density population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of SMALL significance in medium-density population areas where growth-control measures are not in effect. Although DAEC is located in a high population area, Linn and Benton Counties are not subject to growth-control measures that would limit housing development, therefore, any DAEC employment-related impact on housing availability would likely be SMALL. FPL-DA has indicated that employment levels at DAEC would remain relatively constant with no additional demand for housing during the license renewal term. In addition, the number of available housing units has kept pace with growth in the area population. Based on this information, there would be no impact on housing during the license renewal term beyond what has already been experienced.

4.9.3 Public Services: Public Utility Impacts

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to demand and thus there is no need to add capital facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if services (e.g., water, sewer) are substantially degraded and additional capacity is needed to meet ongoing demand. The GEIS indicated that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies.

The Staff's analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. Section 2.1.7 of this DSEIS describes the DAEC permitted withdrawal rate and actual use of water.

As discussed in Chapter 2, DAEC provides potable water for drinking, pump seal cooling, sanitation, and fire protection through the onsite groundwater well system. DAEC does not use water from a municipal system and plant groundwater usage during the renewed license period of operations would be considered SMALL. Further, no increase in plant demand is projected.

DAEC operations during the license renewal term would also not increase plant-related population growth demand for public water and sewer services. Since FPL-DA has indicated that overall employment levels at DAEC would remain relatively constant with no additional demand for public services, both public and private water systems in the region would be adequate to provide the capacity and to meet the demand of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

4.9.4 Offsite Land Use

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal." Section 4.7.4 of the GEIS defines the magnitude of land use changes as a result of plant operation during the license renewal term as follows:

- **SMALL**—little new development and minimal changes to an area's land use pattern
- **MODERATE**—considerable new development and some changes to the land use pattern
- **LARGE**—large-scale new development and major changes in the land use pattern

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small, relative to the community's total revenue, tax driven land use changes during the plant's license renewal term would be SMALL, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If the plant's tax payments are projected to be MODERATE to LARGE relative to the community's total revenue, new tax-driven land use changes would be MODERATE. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land use changes would be LARGE. This would be especially true if the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

4.9.4.1 *Population-Related Impacts*

Since FPL-DA has indicated that they have no plans to add non-outage employees during the license renewal period, there would be no noticeable change in land use conditions in the vicinity of DAEC. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

4.9.4.2 *Tax-Revenue-Related Impacts*

As discussed in Chapter 2, FPL-DA pays annual real estate taxes to Linn County. For the four-year period from 2005 through 2008, tax payments to Linn County represented between 0.3 and

0.4 percent of the county's total property tax revenue collections. Since FPL-DA started making payments to local jurisdictions, population levels and land use conditions in Linn County have not changed significantly, which may indicate that these tax revenues have had little or no effect on land use activities within the county.

FPL-DA has indicated that it plans no construction refurbishment activities to support the continued operation of DAEC during the license renewal period. Accordingly, there would be no increase in the assessed value of DAEC, and annual property tax payments to Linn County would be expected to remain relatively unchanged throughout the license renewal period. Based on this information, there would be no land use impacts related to tax revenue during the license renewal term beyond those already being experienced.

4.9.5 Public Services: Transportation Impacts

Table B-1 in 10 CFR Part 51 states the following:

> Transportation impacts (level of service) of highway traffic generated during the term of the renewed license are generally expected to be of SMALL significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of MODERATE or LARGE significance at some sites.

The regulation in 10 CFR 51.53(c)(3)(ii)(J) requires all applicants to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license. Since FPL-DA has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service would remain unchanged. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

4.9.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the potential effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the *National Register of Historic Places* (NRHP). The criteria for eligibility include: (1) association with significant events in history; (2) association with the lives of persons significant in the past; (3) embodiment of distinctive characteristics of type, period, or construction; and (4) association with or potential to yield important information on history or prehistory. The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in Title 36, "*Parks, Forests, and Public Property*," Part 800, "*Protection of Historic Properties*," of the *Code of Federal Regulations* (36 CFR Part 800). The issuance of a renewed operating license for a nuclear power plant is a Federal undertaking that could possibly affect either known or potential historic properties located on or near the plant and its associated transmission lines. In accordance with the provisions of the NHPA, NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect. If no historic properties are present or affected, NRC is required to notify the State Historic Preservation Office (SHPO) before proceeding. If it is determined that historic properties are present, NRC is required to assess and resolve possible adverse effects of the undertaking.

In April 2007, DAEC contacted the State Historical Society of Iowa concerning the relicense application being submitted by DAEC to the NRC. The State Historical Society of Iowa did not respond to the letter. NRC contacted the Iowa SHPO by letter on May 7, 2009 concerning the proposed relicensing of DAEC. NRC also contacted the Iowa State Archaeologist and the Advisory Council on Historic Preservation by letter dated May 7, 2009. NRC contacted seventeen Native American tribes in association with the relicensing action (see Appendix E).

Five archaeological investigations have taken place on the DAEC property. Surveys have examined roughly 16.1 ac of the 900-ac property. The ER conducted for the initial construction of the DAEC in 1973 did not identify any historic or archaeological resources. However, the final environmental statement (FES) acknowledged that surveys were being conducted for the Pleasant Creek Reservoir to the northwest of the DAEC (AEC, 1973). The Pleasant Creek Reservoir surveys were the first systematic surveys conducted in the vicinity of the plant. Fifty-five archaeological sites were identified during the Pleasant Creek survey (Benn, 1974).

In 1993, an archaeological survey sponsored by Linn County titled the Archaeological, Historical, and Architectural Survey of Fayette Township in Linn County, Iowa, examined several areas near and at the DAEC. The survey, which focused on historic era properties, identified the remains of four historic era sites on the DAEC property. The first site 13LN362 is an artifact scatter associated with a mid-19th century farmstead. Rogers and Page recommended that site 13LN362 not be deemed eligible for listing on the NRHP (Rogers and Page, 1993). The second site, 13LN363, is the remains of a late 19th century farmstead; it was recommended as potentially eligible for listing on the NRHP (Rogers and Page, 1993). A limestone well is visible at the site. The third site, 13LN365, is a late 19th century farmstead that Rogers and Page recommended as potentially eligible for the NRHP. The final site, 13LN366, is an artifact scatter dating to the late 19th century; this site was recommended as potentially eligible by Rogers and Page.

The next three surveys conducted at DAEC occurred between 2000 and 2006. An 8.5-acre survey of an independent spent fuel storage facility conducted in 2001 by the University of Iowa did not identify any archaeological remains (UI, 2001). In 2005, the Louis Berger Group, Inc. conducted an archaeological survey of 7 acres for a cellular communications tower. No archaeological material was identified (Higginbottom 2005). The final field survey conducted on DAEC property examined a 1.9 acre area of shoreline along the Cedar River. The survey, conducted by the Louis Berger Group, did not identify any archaeological remains (Louis Berger Group, Inc. 2006).

In 2008, DAEC contracted with Louis Berger Group, Inc. to perform a historic document review for the entire 900-acre property in anticipation of license renewal. The archival research identified five locations on the DAEC property that could contain historic and archaeological remains in addition to the four known archaeological sites (Louis Berger Group, Inc., 2008). The records indicate the potential presence of four residences or farmsteads and a platted townsite on the DAEC site. The report does not agree with the 1993 recommendation by Rogers and

Page that site 13LN362 is not eligible for listing on the NRHP. It recommends that 13LN362 be considered potentially eligible until further testing can be undertaken. Several of the landforms on the DAEC property contain the potential for archaeological remains (Louis Berger Group Inc., 2008). As of July 2009, the SHPO review of the 2008 Louis Berger report had not occurred.

Most impacts to historic and archaeological resources occur during ground disturbing activities. DAEC maintains excavation and trenching procedures. An Staff review of the procedures found that known resources are considered in the excavation and trenching procedures; however, undiscovered historic and archaeological sites could be affected by plant activities. The large numbers of historic and archaeological resources previously found in the vicinity of the DAEC indicate a potential for undiscovered resources to be present on the DAEC. Revised procedures and development of a cultural resources management plan would address potential impacts to both known and undiscovered resources.

The transmission assets connecting DAEC to the grid are owned by ITC Midwest LLC. There are twelve historic and archaeological resources within the DAEC transmission line corridors. Information concerning the resources was provided to ITC. ITC indicated that they would coordinate management of the resources with the SHPO.

DAEC has not proposed any new facilities, service roads, or transmission lines associated with license renewal or refurbishment, therefore, no impacts are expected to historic and archaeological resources from license renewal. However, limitations in the procedures for considering unknown historic and archaeological remains during plant operations and the potential for the presence of unidentified remains on the DAEC property makes the potential for impacts resulting from future operations possible.

Based on the Staff's review of past surveys conducted at the DAEC, procedures for reviewing historic and archaeological materials, and review of the Iowa Historical Society and Iowa State Archaeologist files for the region, the Staff concludes that the potential impacts on historic and archaeological resources at DAEC could be MODERATE. Potential impacts could be minimized or avoided if DAEC develops procedures that more effectively consider historic and archaeological resources, and develops a cultural resource management plan.

Most impacts to historic and archaeological resources occur during ground disturbing activities. DAEC maintains excavation and trenching procedures. A Staff review of the procedures found that known resources are considered in the excavation and trenching procedures however, undiscovered historic and archaeological sites could be affected by plant activities. The large numbers of historic and archaeological resources previously found in the vicinity of the DAEC indicate a potential for undiscovered resources to be present on the DAEC. Revised procedures and development of a cultural resources management plan would address potential impacts to both known and undiscovered resources. DAEC in coordination with the SHPO has revised its excavation and trenching procedures and developed a cultural resource management plan for the plant property. The revised procedures and cultural resource management plan will be implemented once all consulting parties have reviewed and agree that the procedures effectively consider historic and archaeological resources.

DAEC has not proposed any new facilities, service roads, or transmission lines associated with license renewal or refurbishment, therefore, no impacts are expected to historic and archaeological resources from license renewal. However, limitations in the procedures for considering unknown historic and archaeological remains during plant operations and the potential for the presence of unidentified remains on the DAEC property makes the potential for impacts resulting from future operations possible.

Based on the Staff's review of past surveys conducted at the DAEC, review of the procedures for considering historic and archaeological materials at DAEC, and review of the Iowa Historical Society and Iowa State Archaeologist files for the region, the Staff concludes that the potential impacts on historic and archaeological resources at DAEC would be MODERATE. As mentioned, the DAEC is in the process of finalizing its revised procedures and cultural resource management plan. This MODERATE impact could be mitigated (i.e., potential impacts could be reduced) once the revised procedures and cultural resources management plan are implemented.

4.9.7 Environmental Justice

Under Executive Order (E.O.) 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. Although the E.O. is not mandatory for independent agencies such as the NRC, the NRC has voluntarily committed to undertake environmental justice reviews. In 2004, the Commission issued a *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040), which states that "[t]he Commission is committed to the general goals set forth in E.O. 12898, and strives to meet those goals as part of its National Environmental Policy Act (NEPA) review process."

The Council of Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ, 1997). This guidance states:

> **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ, 1997).

> **Disproportionately High and Adverse Environmental Effects.** A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ, 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of DAEC during the renewal term. In assessing the impacts, the following CEQ definitions of minority individuals and populations, and low-income population were used (CEQ, 1997):

> **Minority individuals.** Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

> **Minority populations.** Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

> **Low-income population.** Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the U.S. Census Bureau's (USCB) Current Population Reports, Series PB60, on Income and Poverty.

4.9.7.1 *Minority Population in 2000*

According to 2000 census data, 7.6 percent of the population (approximately 49,296 individuals) residing within a 50-mile radius of DAEC were minority individuals. The largest minority group was Black or African American (18,883 individuals, or 2.9 percent), followed by Hispanic (11,772 individuals, or about 1.8 percent). Approximately 6 percent of the Linn County population are minorities, with Black or African American (2.5 percent) the largest minority group, followed by Hispanic (1.4 percent). In Benton County, 1.2 percent of the population are minorities, with Hispanic (0.6 percent) the largest minority group, followed by Black or African American (0.2 percent).

The 50-mile radius around DAEC consists of each county with at least one census block group located within the 50-mile radius. The population demographic data from these counties were added together to derive average regional percentages. Of the 512 census block groups located wholly or partly within the 50-mile radius of DAEC, 23 block groups were determined to have minority population percentages that exceeded the regional percentages by 20 percentage points or more, or that were more than 50 percent minority. The largest number of minority block groups was Black or African American, with 14 block groups that exceed the regional percentage of 20 percent or more, or that were more than 50 percent Black or African American.

These block groups are concentrated in urban areas with high population densities in Black Hawk County and Linn County. The closest high density minority population to DAEC is located in the city of Cedar Rapids, IA. Based on 2000 census data, Figure 4-1 shows minority block groups within a 50-mile radius of DAEC.

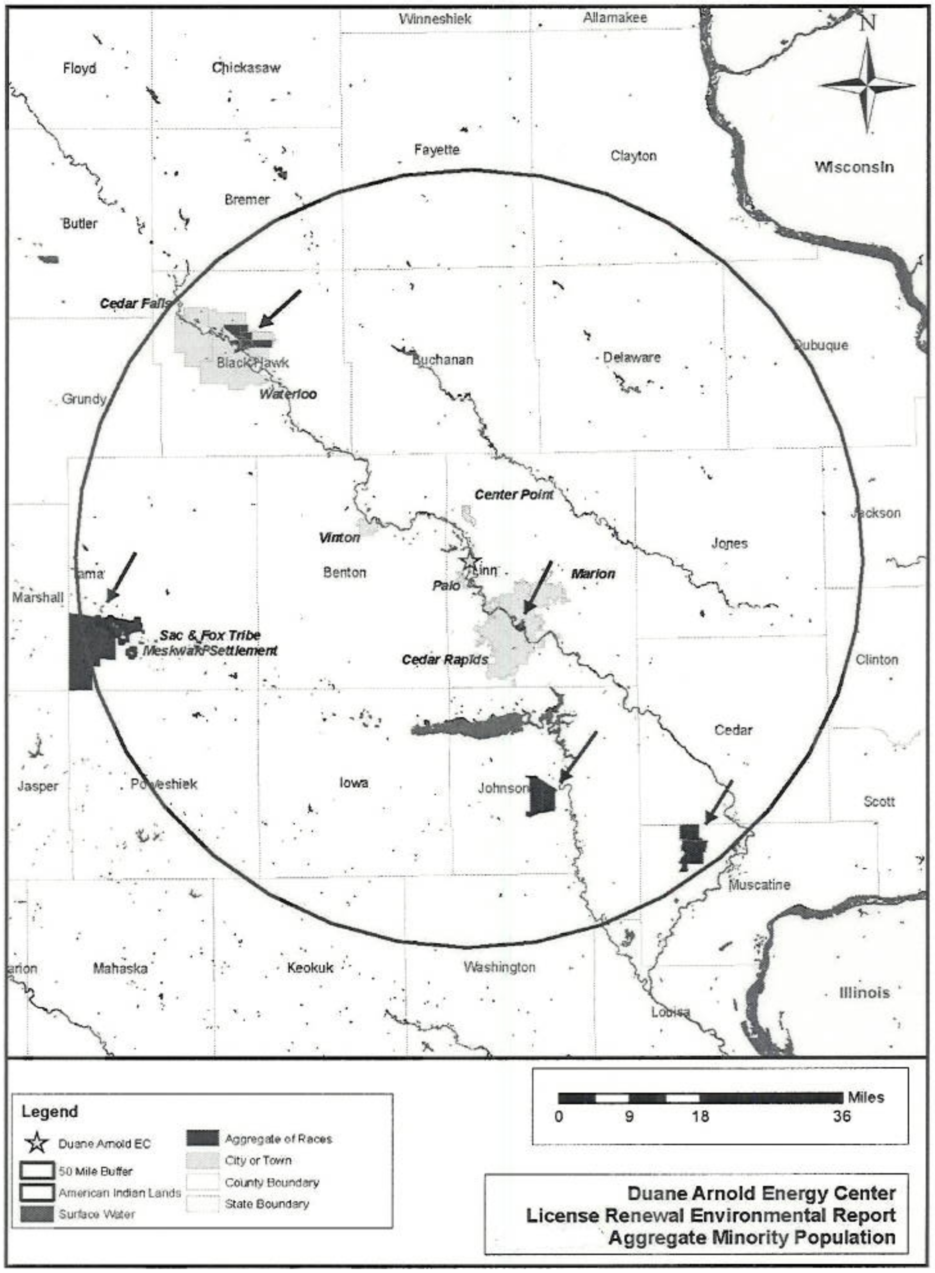

Figure 4-1. Aggregate Minority Population within a 50-Mile Radius of Duane Arnold Energy Center (USCB, 2009). (Source: FPL-DA 2008a, Figure 2.6-3)

4.9.7.2 *Low-Income Population in 2000*

According to 2000 census data, 59,848 individuals (approximately 9.2 percent) residing within a 50-mi radius of DAEC were identified as living below the Federal poverty threshold. The 1999 Federal poverty threshold was $17,029 for a family of four. According to USCB data, the median household income for Iowa in 2007 was $47,324, while 11.0 percent of the State population was determined to be living below the 1999 Federal poverty threshold. Linn County had one of the higher median household incomes ($53,076) in the state, and a lower percentage (9.9 percent) of individuals living below the poverty level, when compared to the State.

Census block groups were considered low-income block groups if the percentage of households below the Federal poverty threshold exceeded the State average by 20 percent or more. Based on 2000 census data, there were 15 block groups within the 50-mile radius of DAEC that exceeded the state average for low income households by 20 percent or more, or that were more than 50 percent low-income. The majority of census block groups with low-income populations were located in Black Hawk County. The nearest high density low-income population to DAEC is located in Cedar Rapids, IA. Based on 2000 census data, Figure 4-2 shows low-income block groups within a 50-mi radius of DAEC.

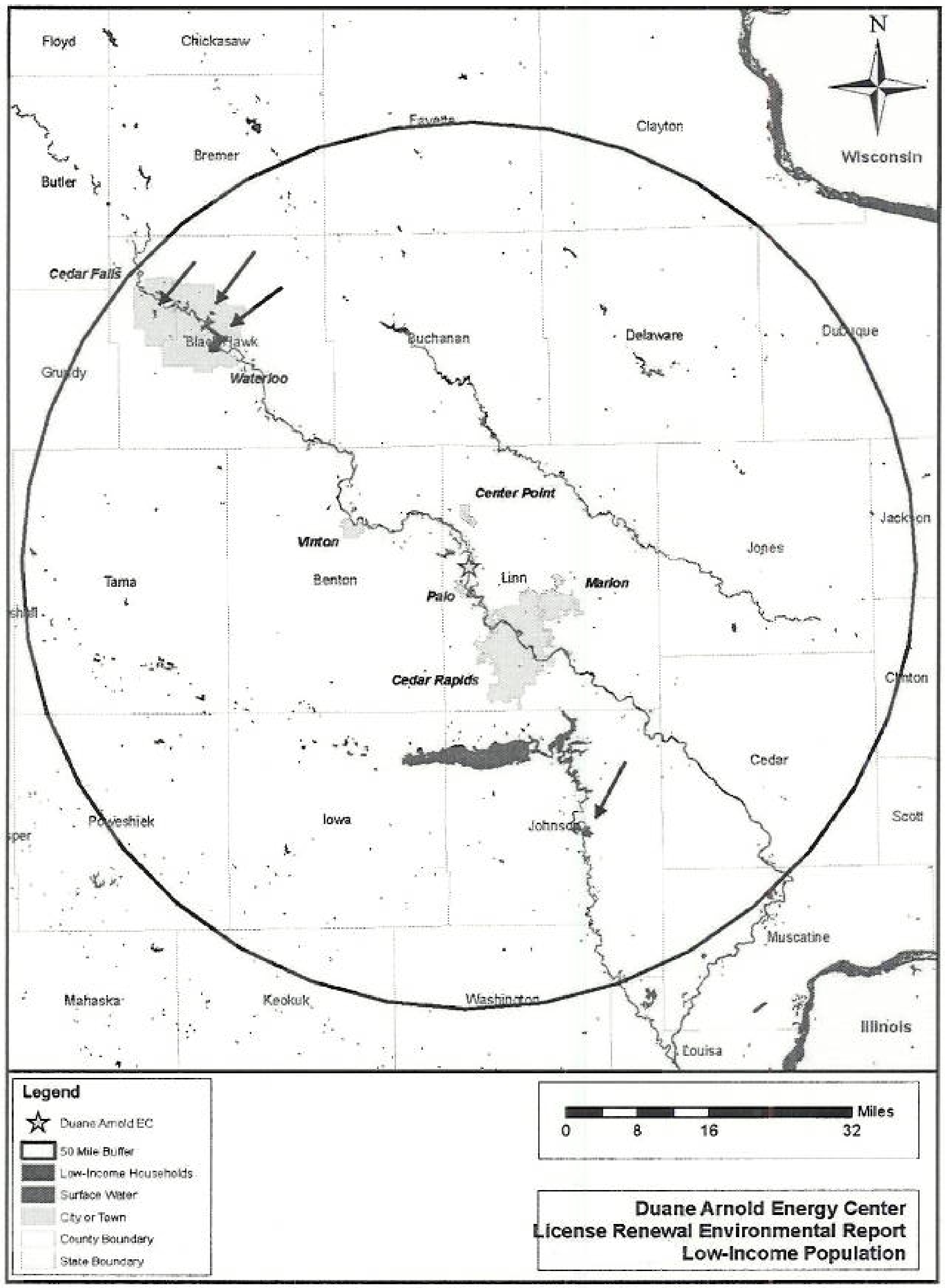

Figure 4-2. Low-Income Population within a 50-Mile Radius of Duane Arnold Energy Center (USCB, 2009). (Source: FPL-DA, 2008a, Figure 2.6-5)

4.9.7.3 *Analysis of Impacts*

Consistent with the impact analysis for public and occupational health and safety, the affected populations are defined as minority and low-income populations who reside within a 50-mi radius of DAEC. Presidential Executive Order (E.O.) 12898 provides direction for assessing high and adverse impacts upon minority and low income populations. Based on the analysis of impacts for other resource areas, there would be no high and adverse impacts from the operation of DAEC during the license renewal period. Because there are no high or adverse impacts, by definition there is also no disproportionate impact upon low income or minority populations.

NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

4.9.7.4 *Subsistence Consumption of Fish and Wildlife*

Section 4-4 of E.O. 12898 (E.O. 12898 1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish or wildlife or both for subsistence, and to communicate the risks of these consumption patterns to the public. In this draft SEIS, NRC considered whether or not there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the DAEC site were considered.

FPL-DA has a comprehensive REMP at DAEC to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways applicable to the site. The aquatic pathways include fish, surface waters, and sediment. The terrestrial pathways include airborne particulates and radioiodine, milk, food products, and direct radiation. During 2007, analyses were performed on collected samples of environmental media as part of the required REMP, which showed no significant or measurable radiological impact from DAEC operations (FPL-DA, 2008d).

No effects of plant operation were found in air quality or precipitation data. Gross radioactive beta concentrations in airborne particulates were identical at the indicator and control locations, and similar to levels observed from 1992 through 2006. Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Weekly levels of airborne iodine-131 were below the lower limit of detection in all samples. Precipitation from an onsite location was analyzed for tritium and gamma-emitting isotopes. No tritium activity was measured and no gamma-emitting isotopes were detected. Downwind rain-water samples measured small concentrations of tritium, with no tritium detected in the upwind samples.

Milk data for 2007 show no radiological effects of plant operation. Iodine-131 results were below detection limits in all samples, and no gamma-emitting isotopes, except naturally occurring potassium-40, were detected in any milk samples.

For potable groundwater, the annual mean gross beta activity was similar to levels observed from 1991 through 2006, with the highest reading found at a farm one mile from the plant. Tritium activity in all samples indicated no effects from plant operation. Twelve onsite groundwater monitoring wells sampled for gross beta and tritium, and analyses for gamma emitting isotopes, strontium-89 and strontium-90 were performed. Although higher beta activity was found, this was most likely from naturally-occurring isotopes. Tritium was identified in one of twenty-four samples taken from the intermediate depth wells. No plant operational effects were indicated in any of the samples. Tritium was identified in five of twenty-four samples taken from the shallow wells; these tritium levels are attributed to gaseous effluents releases.

With the exception of potassium-40, all other gamma-emitting isotopes were below detection limits in vegetation samples (broadleaf, grain, and forage). Measurable strontium-90 and cesium-137 activity was found in soil samples of one out of the two onsite locations; these activity levels are similar to, or lower levels, than those observed from 1991 through 2006, and are primarily attributable to deposition of Chernobyl fallout. With the exception of naturally-occurring potassium-40, no gamma-emitting isotopes were identified in edible portions of fish. River sediments were analyzed for gamma-emitting isotopes. Potassium-40 activity was found, together with Trace Cs-137 activity. All other gamma-emitting isotopes were below detection limits.

The results of the 2007 REMP demonstrate that the routine operation at the DAEC site had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of the plant did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents (FPL-DA, 2008d). REMP continues to demonstrate that the dose to a member of the public from the operation of DAEC remains significantly below the federally required dose limits specified in 10 CFR Part 20, “Standards for Protection against Radiation,” and Title 40, “Protection of Environment,” Part 190, “Environmental Radiation Protection Requirements for Normal Operations of Activities in the Uranium Fuel Cycle” (40 CFR Part 190).

Based on recent monitoring results, concentrations of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals in areas surrounding DAEC have been quite low (at or near the threshold of detection) and seldom above background levels (FPL-DA, 2009d). Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.10 EVALUATION OF NEW AND POTENTIALLY SIGNIFICANT INFORMATION

New and significant information is: (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the DAEC operating license, FPL-DA developed a process to ensure that information not addressed in nor available during, the GEIS evaluation regarding the environmental impacts of license renewal for DAEC, would be properly reviewed before submitting the ER, and to ensure that such new and potentially significant information related to renewal of the operating license for DAEC would be identified, reviewed, and assessed during the period of NRC review. FPL-DA staff reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to DAEC. This review was performed by personnel from DAEC and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The Staff also has a process for identifying new and significant information. That process is described in detail in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC, 1999b). The search for new information includes: (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies, and (5) review of the technical literature. New information discovered by the Staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that are not affected by the new information.

The Staff has not identified any new and significant information on environmental issues listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, related to the operation of DAEC during the period of license renewal. The Staff also determined that information provided during the public comment period did not identify any new issues that require site-specific assessment. The Staff reviewed the discussion of environmental impacts in the GEIS (NRC, 1996) and conducted its own independent review (including two public scoping meetings held in April 2008) to identify new and significant information.

4.11 CUMULATIVE IMPACTS

The Staff considered potential cumulative impacts in the environmental analysis of continued operation of DAEC. For the purposes of this analysis, past actions are those related to the resources at the time of the power plant licensing and construction; present actions are those related to the resources at the time of current operation of the power plant; and future actions are considered to be those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license term as well as the 20-year renewal license term. The geographic area over which past, present, and future actions would occur is dependent on the type of action considered and is described below for each impact area.

4.11.1 Land Use

Consistent with the findings in the GEIS, the Staff concludes that the impacts from continued operation of the DAEC on land use are SMALL. For the purposes of this cumulative impact assessment, the spatial bounds of consideration include the region within a 50-mi radius of the site and the transmission line corridors. The Staff concludes that when combined with other past, present, and reasonably foreseeable future actions, the cumulative impact of DAEC-related actions during the term of license renewal on land use would be SMALL.

4.11.2 Cumulative Air Quality Impacts

DAEC is located in Linn County, Iowa, which belongs to the EPA Region VII. Linn County is a part of the Northeast Iowa Intrastate Air Quality Control Region as codified in 40 CFR §81.256. All counties in the State of Iowa are currently in attainment for all NAAQS.

In the “2008 FPL Group Sustainability Report,” Florida Power and Light (FPL) highlighted the environmental goals of the company with the emphasis on lowering greenhouse gas (GHG) emissions by at least 50 percent below 2000 levels by 2050 and implementing energy efficiency measures along with the use of the renewable resources (FPL, 2009).

The Iowa Climate Change Advisory Council (ICCAC) was created after the Iowa General Assembly enacted Senate File 485 related to GHG emissions in 2007 and House File 2571 in 2008. ICCAC, with the technical assistance of the U.S. Center for Climate Strategies, evaluated and addressed policies, cost-effective strategies, and multiple scenarios designed to reduce statewide GHG emissions. The developed proposals were compiled into the 2008 ICCAC final report and submitted to the Governor of Iowa and General Assembly (ICCAC, 2008).

Potential cumulative effects of climate change on the area of eastern Iowa, which is part of the midwestern region, whether or not from natural cycles or anthropogenic (man-induced) activities, could result in a variety of changes to the air quality of the area. As projected in the “Global Climate Change Impacts in the United States” report by United States Global Change Research Program (USGCRP, 2009), the temperatures in the Midwest are expected to rise, causing more frequent extreme weather events. Increases in average annual temperatures, higher probability of extreme heat events, higher occurrences of extreme rainfall (intense rainfall or drought) and changes in the wind patterns could affect concentrations of the air pollutants and their long-range transport, because their formation partially depends on the temperature and humidity and is a result of the interactions between hourly changes in the physical and dynamic properties of the atmosphere, atmospheric circulation features, wind, topography and energy use (IPCC, 2009).

Consistent with the findings in the GEIS, the Staff concludes that the impacts from continued operation of the DAEC on air quality are SMALL. As no refurbishment is planned at DAEC during license renewal period, no additional air emissions would result from refurbishment activities (FPL-DA 2008a). In comparison with construction and operation of a comparable fossil-fueled power plant, license renewal would result in a net cumulative deferral of GHG emissions, which would otherwise be produced if a new gas or coal-fired plant were instead constructed. When compared with the alternative of a new fossil-fuel power plant, the option of license renewal also results in a substantial net cumulative deferral in toxic air emissions.

For the purpose of this cumulative air impact assessment, the spatial bounds includes the Northeast Iowa Intrastate Air Quality Control Region. The Staff concludes that combined with the emissions from other past, present, and reasonably foreseeable future actions, cumulative hazardous and criteria air pollutants emissions on air quality from DAEC-related actions would be SMALL. When considered with respect to an alternative of building a fossil-fuel powered plant, continuing the operation of the DAEC could constitute a net cumulative beneficial environmental impact in terms of emissions offsets (i.e., reducing hazardous, criteria, and GHG air emissions) that would otherwise be generated by a fossil-fuel plant; only the Combined Alternative (described in Chapter 6) would be equivalent to or would contribute less cumulative emissions than the option of license renewal.

4.11.3 Cumulative Impact on Water Resources

For the purposes of this cumulative impact assessment, the spatial bounds of the groundwater system is the alluvial aquifer and Wapsipinicon and Gower aquifer formations; and the surface water boundary is the Cedar River Basin. Cedar Rapids, IA, is about 15 miles (24 km) downstream of the DAEC. The Cedar Rapids Water Department draws its water supply from the alluvium along the river, relying on four well fields with four collector wells and 45 vertical wells. The average supply rate to residential and industrial customers is 35 million gal/day (130,000 m^3/day).

Actions that can impact groundwater and surface water resources in the region include overuse of groundwater and surface water resources, unregulated use of water resources, drought impacts, and the need for flow compensation for consumptive water users. Similar impacts from future activities are likely to continue in the future.

Within the DAEC local area, private well users are not known to have experienced issues with declining water levels in their wells. Therefore, it appears reasonable that the use of groundwater by the plant is not contributing to a significant cumulative effect on local groundwater users or larger regional users. Based on this reasoning, the Staff concludes that when added to the groundwater usage from other past, present, and reasonably foreseeable future actions, the cumulative impact on groundwater use is SMALL.

During a drought, the effect of low-flow river conditions on the Cedar River would be magnified and could constitute a cumulative impact. As discussed in Section 2.1.7.2, flow in the Cedar River at Cedar Rapids averages 3,878 cfs. Flow at DAEC is expected to be similar because no major tributaries enter the river between the facility and Cedar Rapids. The design rate for water withdrawal under operating conditions is 11,200 gpm (25 cfs or 0.71 m^3/s), or approximately 0.6 percent of the average river flow.

Section 4.3.3 describes NRC's requirements for assessing water use conflicts on a "small river" Specifically. During Cedar River low-flow periods, the withdrawal rate and consumptive rate are higher proportions of the river flow. By permit, when river flow falls below 500 cfs (14 m^3/s), the Pleasant Creek Recreational Reservoir may discharge to the Cedar River at a rate equal to the consumptive use rate of 18 cfs (0.51 m^3/s) (IDNR, 2005). At this low-flow threshold, flow in the river is only 13 percent of the average flow, the withdrawal rate is 5 percent of the low flow, and the return of blowdown to the river results in a net consumptive rate of over 3 percent of the low flow. Discharge from the reservoir is not a requirement of the permit. The cumulative effect on users of the river for water supply, for recreation, and for aquatic habitat could become significant. For this reason, the Staff concludes that when added to the surface water usage from other past, present, and reasonably foreseeable future actions, the cumulative impact on surface water use is SMALL to MODERATE.

4.11.4 Cumulative Impacts on Aquatic Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts to aquatic resources within the Cedar River. The headwaters of the Cedar River are located in Dodge County, Minnesota, where its tributaries, the Little Cedar and the Shell Rock Rivers merge. The Cedar River flows southeast for 329 miles (529 km) through Iowa to its confluence with the Iowa River in Columbus Junction, Louisa County, Iowa, about 30 miles (48 km) upstream of the mouth of the Iowa River (Sullivan, 2000). For purposes of this analysis, the geographic area considered for cumulative impacts on aquatic resources is the Cedar River Basin.

Water quality is of concern in the Cedar River and multiple stretches of the river are on the Clean Water Act (CWA) Section 303(d) 2008 list of impaired waters for high levels of bacteria, algae, polychlorinated biphenyls (PCBs) in fish, and mercury in fish (IDNR, 2008). Eight total areas have been identified as "impaired," none of which currently have a water quality improvement plan in place (IDNR, 2008). "Impaired," as defined by IDNR does not necessarily mean that the water body is highly polluted. Many waters on the 2008 303(d) list are considered "impaired" rather than "fully supported" due to the absence of only a few key aquatic species, but these waters can continue to support a moderate level of aquatic diversity (IDNR 2009b). However, for those waters with high levels of bacteria, the designation of "impaired" may indicate potential risks to recreational use (IDNR, 2009b). Because of the high percentage of agricultural land along the Cedar River, the majority of the pollution originates from nonpoint sources including pesticide and other chemical runoff, soil erosion, and nutrient loading from fertilizers and other organic sources. The IDNR has a Nonpoint Source Management Program to address some of these issues across the State.

Current municipal and industrial effluents to the Cedar River in the vicinity of DAEC are, and will continue to be, regulated through NPDES permits by the IDNR. For facilities using the Cedar River as a source of cooling water, the NPDES permit will also contain regulations pertaining to the impingement and entrainment of fish and shellfish and temperature limits on heated effluents to the river. The IDNR periodically reviews and renews NPDES permits, thus regulating the flow of industrial effluents to the river in a manner that preserves water quality and protects aquatic resources from impingement and entrainment through implementation of the best technology available and other mitigative measures.

Because the Cedar River is not a major navigational travel route, channelization and dredging is not an issue at this time. Erosion from severe weather and flooding has likely affected sedimentation and clarity of the Cedar River, which may affect fish habitat locally, though this impact is not expected to significantly alter any fish populations.

As no protected terrestrial species are known to occur on or in the vicinity of the DAEC site, protected species, discussed in Section 2.2.7, are not expected to be adversely affected due to future actions during the renewal term.

The Staff examined the cumulative effects of effluents on Cedar River water quality, impacts to protected species, and effects of neighboring facilities. The Staff concludes that the minimal aquatic impacts on the continued DAEC operations would not contribute to the overall decline to the condition of aquatic resources. The Staff believes that the cumulative impacts of DAEC-related actions during the term of license renewal on aquatic habitat and associated species, when added to past, present, and reasonably foreseeable future actions would be SMALL.

4.11.5 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources, including wildlife populations, prairie and woodlands, riparian zones, invasive species, protected species, and land use. For purposes of this analysis, the geographic area considered in this evaluation includes the DAEC site and in-scope transmission line ROWs.

Approximately 100 ac (40 ha) of the 500-ac (200-ha) site was originally disturbed for plant construction and associated machinery (AEC, 1973). In total, 140 ac (57 ha) contain the generating facility, associated buildings, switchyard, parking lots, and mowed areas (FPL-DA 2008a). The site is situated on the western bank of the Cedar River. Before DAEC was constructed, the majority of the site's land was cultivated with some grassland and woodland areas on and near the site (FPL-DA, 2008a). Because the land was previously farmed, no trees were removed during construction of DAEC (AEC, 1973). Removal of vegetation on the bank of the Cedar River for intake and discharge construction resulted in some erosion of the river bank; however the FES (AEC, 1973) states that the applicant replanted these areas after construction to mitigate the effects of clearing the area.

Construction of the transmission lines required 1,155 ac (467 ha) to be disturbed for the 85 miles (137 km) of lines constructed for plant operation (AEC, 1973). About 21 percent, or 18 miles (29 km), of the constructed lines were routed along public roads or railroads and utilized existing ROWs, which minimized the impact of land disturbance associated with line construction and ROW clearance. The remaining 67 miles (108 km) of constructed lines were constructed over private property, of which 85.9 percent was previously cultivated, 6.5 percent was pasture, 3.6 percent was wooded, and 4.0 percent was marshland (AEC, 1973). Some minor habitat fragmentation may have occurred as a result of line construction and ROW clearance through forested and marsh areas, which may have resulted in edge effects such as changes in light, wind, and temperature, changes in abundance and distribution of interior species, and reduced habitat ranges for certain species. ROW maintenance has likely had past impacts and is likely to have present and future impacts on the terrestrial habitat, which may include bioaccumulation of chemicals, prevention of the natural successional stages of the surrounding vegetative communities in the ROWs, an increase in abundance of edge species, a decrease in abundance of interior species, and an increase in invasive species populations.

As no protected terrestrial species are known to occur on or in the vicinity of the DAEC site, protected species, discussed in Section 2.2.7, are not expected to be adversely affected due to future actions during the renewal term. Numerous parks and natural areas are located in the vicinity of the DAEC site, which will continue to provide habitat for protected species and other wildlife.

The Prairie Creek Generating Station, owned by Interstate Power and Light Company and operated by Alliant Energy, is located along the Cedar River approximately 20miles (32 km) downstream of DAEC in Cedar Rapids, IA. The 245-megawatt (MW) coal-fired plant began operation in 1951 and has a total of four units, the latest of which began operating in 1997. In addition to the Prairie Creek Generating Station, five other fossil-fuel fired generating facilities are located within a 50-mi (80-km) radius of DAEC. These facilities are the 6th Street Generating Station and the Archer Daniels Midland Cedar Rapids Plant, both in Cedar Rapids, IA; and the Streeter Station, the Electrifarm Generating Station, and the Cedar Falls Gas Turbine Station, which are in Black Hawk County, Iowa (FPL-DA, 2008a). Coal-fired plants are a major source of air pollution in the United States because they release sulfur dioxide, nitrogen oxides, mercury, carbon dioxide, and particulates. Nitrous oxides and sulfur dioxides combine with water to form acid rain, which can lead to erosion and changes in soil pH levels. Mercury deposits onto soil and surface water, which may then be taken up by terrestrial and aquatic plant or animal species and pose the risk of bioaccumulation. For these reasons, the Prairie Creek Generating Station is likely to have current and future adverse effects to the environment in the Cedar River Basin.

The majority of land surrounding the DAEC site is rural and used for agricultural purposes. Pesticide and herbicide runoff is a primary contributor of water pollutants in the Cedar River and its tributaries. Additionally, the cities of Waterloo, Iowa City, and Cedar Rapids lie 34 miles (55 km) to the northwest, 32 miles (52 km) to the northeast, and 5.7 miles (9.2 km) to the southeast of DAEC, respectively. Continued development of these areas may result in additional runoff from roads and impervious surfaces, development adjacent to wetlands and riparian zones, and an increase in waste releases, all of which could have adverse impacts on terrestrial habitat.

The Staff examined the cumulative effects of initial construction of the site and transmission lines, impacts to protected species, effects of neighboring facilities, and continued land development in the Cedar Rapids area. The Staff concludes that the minimal terrestrial impacts on the continued DAEC operations would not contribute to the overall decline in the condition of terrestrial resources. The Staff believes that the expected cumulative impacts of other and future actions during the term of license renewal on terrestrial habitat and associated species, when added to past, present, and reasonably foreseeable future actions, are SMALL.

4.11.6 Cumulative Human Health Impacts

The NRC and the EPA established radiological dose limits for protection of the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. As discussed in Section 4.8.1, the doses resulting from operation of DAEC are below regulatory limits and the impacts of these exposures are SMALL. For the purposes of this cumulative impact analysis, the geographical area involves a 50-mile (80-km) radius around the DAEC site.

EPA regulations in 40 CFR Part 190 limit the dose to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste. In addition, as discussed in Section 4.8.1, DAEC conducts a radiological environmental monitoring program around its site, which was initiated before commercial operation began in 1975. This program measures radiation and radioactive materials from DAEC and all other sources.

As discussed in Section 4.8.1 of this report, the Staff reviewed the radiological environmental monitoring results for DAEC over the five-year period from 2004–2008 as part of this cumulative impacts assessment. Cumulative radiological impacts from all uranium fuel cycle facilities within a 50-mi (80-km) radius of the DAEC site are limited by the dose limits in 10 CFR Part 20 and 40 CFR Part 190. There are no other uranium fuel-cycle facilities within a 50-mi (80-km) radius of DAEC.

Based on the Staff's review of DAEC's radiological environmental monitoring results, the radioactive effluent release data, and the expected continued compliance with Federal radiation protection standards, the cumulative radiological impacts to human health when combined with all past, present, and reasonably foreseeable future actions would be SMALL. The NRC and the State of Iowa will regulate any future development or actions in the vicinity of the DAEC site that could contribute to cumulative radiological impacts.

As discussed in Section 4.8.2, the continued operation of DAEC has a low risk of causing outbreaks from thermophilic microbiological organisms associated with thermal discharges. Available data compiled into biannual reports by the CDC for the years 1999 to 2006 (CDC 2000, 2002, 2004, 2006) indicates no occurrence of waterborne disease outbreaks in the State of Nebraska resulting from exposure to the thermophilic microbiological organisms *Naegleria fowleri* and *Pseudomonas aeruginosa.*

As part of its evaluation of cumulative impacts, the Staff also considered the effects of thermal discharges from other facilities on the Cedar River located within one mile upstream of DAEC that are also producing thermal effluents. Such facilities could promote the growth of thermophilic microbiological organisms. The Staff did not identify any such facilities. The Staff concludes that, thermophilic microbiological organisms are not likely to present a public health hazard as a result of DAEC discharges to the Cedar River. The Staff concludes that when combined with other past, present, and reasonably foreseeable future actions, the cumulative impact on public health from thermophilic microbiological organisms would be SMALL.

The Staff determined that the DAEC transmission lines are operating within original design specifications and meet current NESC clearance standards. The DAEC transmission lines, when combined with other past, present, and reasonably foreseeable future electrical sources, contribute only a SMALL cumulative potential for electric shock.

With respect to the chronic effects of EMF, although the GEIS finding of “uncertain” is appropriate to DAEC, the transmission lines associated with DAEC are not likely to detectably contribute to the regional exposure of extremely low frequency electromagnetic fields. Therefore, the Staff has determined that when combined with other past, present, and reasonably foreseeable future actions, the continued operation of the DAEC transmission lines on cumulative chronic EMF impacts would be SMALL.

4.11.7 Cumulative Socioeconomic Impacts

For the purposes of this cumulative impact assessment, the geographical bounds of the analysis are Lynn and Benton Counties. As discussed in Section 4.9 of this DSEIS, the continued operation of DAEC during the license renewal term would have no measurable impact on socioeconomic conditions in the region beyond those already being experienced. Since FPL-DA has indicated that there would be no major plant refurbishment, and overall expenditures and employment levels at DAEC would remain relatively constant with no additional demand for housing, public utilities, and public services. In addition, since employment levels and the value of DAEC would not change, there would be no population and tax revenue-related land-use impacts. There would also be no disproportionately high or adverse health or environmental impacts on minority and low-income populations in the region.

Based on this and other information presented in the DSEIS, the cumulative socioeconomic impact from continued operation of the DAEC, when combined with other past, present, and reasonably foreseeable future actions would be SMALL.

4.11.8 Historic and Archaeological Resources Cumulative Impacts

As discussed in Section 4.9.6, continued operation of DAEC during the license renewal term has the potential to impact both known and undiscovered historic and archaeological resources. Revised procedures and development of a cultural resources management plan would address potential impacts to both known and undiscovered resources. NRC has concluded that the impacts of continued operation could have a MODERATE impact on historic and archaeological resources.

Past activities have included site clearing, and construction of facilities, parking lots, security trenches, roads, and other ancillary structures, as well as clearing, construction, and maintenance of the transmission line corridors.

For the purposes of this cumulative impact assessment, the spatial bounds includes the DAEC site and transmission lines corridors. Cumulative impacts to historic and archaeological resources can result from the incremental loss of unique site types. DAEC has no plans to alter the DAEC site for license renewal. Any land disturbing activities would be considered through the DAEC excavation and trenching procedures. Given that DAEC plant property has the potential for unknown resources, the Staff concludes that when combined with other past, present, and reasonably foreseeable future land disturbing activities, the potential cumulative impacts on historic and archaeological resources could be MODERATE. Cumulative impacts could be partly mitigated through application of the mitigation measures discussed in Section 4.9.6.

4.11.9 Summary of Cumulative Impacts

The Staff considered the potential impacts resulting from operation of DAEC during the period of extended operation and other past, present, and reasonably foreseeable future actions in the vicinity of DAEC. The preliminary determination is that the potential cumulative impacts resulting from DAEC operation during the period of extended operation would range from SMALL to MODERATE. Table 4-12 summarizes the cumulative impact by resource area.

1 **Table 4-12. Summary of Cumulative Impacts on Resource Areas**

Resource Area	Impact	Summary
Land use	SMALL	With respect to the DAEC facility, no measurable changes in land use would occur over the proposed license renewal term. When combined with other past, present, and reasonably foreseeable future activities, impacts from continued operation of DAEC would constitute a SMALL cumulative impact on land use.
Air quality resources	SMALL	Impacts of air emissions over the proposed license renewal term would be SMALL. When combined with other past, present, and reasonably foreseeable future activities, impacts to air resources from the DAEC would constitute a SMALL cumulative impact on air quality. In comparison with the alterative of constructing and operating a comparable gas or coal-fired power plant, license renewal would result in a net cumulative deferral in both GHG and other toxic air emissions, which would otherwise be produced by a fossil-fueled plant.
Water resources	SMALL to MODERATE	Water taken from the Cedar river to support DAEC operations constitutes a SMALL effect upon water usage and conflicts, When this DAEC water consumption is added to other past, present, and reasonably foreseeable future withdraws, cumulative impact upon the Cedar River is SMALL. Similarly, the Staff concludes that DAEC groundwater consumption, when added to groundwater usage from other past, present, and reasonably foreseeable future withdraws also constitutes a SMALL cumulative impact on groundwater on the resource. However, when combined with surface water usage from other past, present, and reasonably foreseeable future Cedar River withdraws, the cumulative consumption impact is SMALL to MODERATE.
Aquatic resources	SMALL	Past and present impacts have impacted aquatic resources; and, continued impacts from agricultural and other development activities have impacted aquatic resources, with such effects likely to continue in the future. When combined with other past, present, and reasonably foreseeable future activities, impacts from continued operation of DAEC would constitute a SMALL cumulative impact on aquatic resources.
Terrestrial resources	SMALL	Past and present impacts have impacted terrestrial habitat and species in the vicinity of DAEC, and would likely continue in the future. When combined with other past, present, and reasonably foreseeable future activities, impacts from continued operation of DAEC would constitute a SMALL cumulative impact on aquatic resources.
Human Health	SMALL	When combined with the other past, present, and reasonably foreseeable future activities, the cumulative human health impacts of continued operation of DAEC from radiation exposure to the public, microbiological organisms from thermal discharge to the Cedar River, and electric-field-induced currents from the DAEC transmission lines would all be negligible to SMALL.
Socioeconomics	SMALL to	When combined with the other past, present, and reasonably

Resource Area	Impact	Summary
	MODERATE	foreseeable future activities, impacts to socioeconomic resources (with the exception of historic and archaeological) from continued operation of DAEC have no measurable cumulative impact. However, the potential cumulative land disturbance impact on historic and archaeological resources could be MODERATE.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes the environmental impacts from postulated accidents that the Duane Arnold Energy Center (DAEC) might experience during the period of extended operation. For a more detailed discussion of this assessment, the reader is referred to Appendix G. The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Two classes of postulated accidents are evaluated in the *Generic Environmental Impact Statements (GEIS) for License Renewal of Nuclear Power Plants* prepared by the U.S. Nuclear Regulatory Commission (NRC), as listed in Table 5-1. These two classes include:

- design-basis accidents (DBAs)
- severe accidents

Table 5-1. Issues Related to Postulated Accidents. *Two issues related to postulated accidents are evaluated under the National Environmental Policy Act (NEPA) in the license renewal review: design-basis accidents and severe accidents.*

Issues	GEIS Section	Category
Design-basis accidents	5.3.2; 5.5.1	1
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	2

Generic issues (Category 1 issues, see Chapter 1) rely on the analysis provided in the GEIS and are discussed briefly (NRC 1996,1999a).

5.1 DESIGN BASIS ACCIDENTS

As part of the process for receiving NRC approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff (Staff) reviews the application to determine whether or not the plant design meets the NRC's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the Staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in Title 10 of the *Code of Federal Regulations* (CFR) Parts 50 and 100.

The environmental impacts of DBAs are evaluated during the initial licensing process. Before a license renewal is issued, the DBA assessment must demonstrate that the plant can withstand these accidents. The results of these evaluations are found in license documentation such as the applicant's final safety analysis report (FSAR), the safety evaluation report (SER), the final environmental statement (FES), and Section 5.1 of this draft supplemental environmental impact statement (SEIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for the period of extended operation, the environmental impacts, as calculated for DBAs, should not differ significantly from initial licensing assessments over the life of the plant, including the period of extended operation. Accordingly, the design of the plant relative to DBAs during the period of extended operation is considered to remain acceptable and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the significance level of the environmental impacts of DBAs are SMALL for all plants because the plants were designed to successfully withstand these accidents. For the purposes of license renewal, DBAs have been designated as a Category 1 issue. The early resolution of the DBAs makes them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal.

No new and significant information related to DBAs was identified during the review of FPL Energy Duane Arnold, LLC's (FPL-DA) environmental report (ER) (FPL-DA, 2008), site audit, scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

5.2 SEVERE ACCIDENTS

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the Staff assessed the impacts of severe accidents during the period of extended operation, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the period of extended operation.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in FESs and were not specifically considered for the DAEC site in the GEIS (NRC, 1996). However, the GEIS did evaluate existing impact assessments performed by the Staff and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal performed a discretionary analysis of sabotage in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the NRC concludes that the risk from sabotage and beyond design-basis earthquakes at existing nuclear power plants is small, and additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (NRC, 1996).

Based on information in the GEIS, the NRC found that:

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

The Staff identified no new and significant information related to postulated accidents during the review of FPL-DA's ER (FPL Energy, 2008), the site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. However, in accordance with Title 10 CFR 51.53(c)(3)(ii)(L), the Staff reviewed severe accident mitigation alternatives (SAMAs) for the DAEC. The results of the review are discussed in Section 5.3.

5.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

The Federal regulation 10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the Staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS), related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance, are identified and evaluated. SAMAs have not been previously considered for DAEC, therefore, the remainder of Chapter 5 addresses those alternatives.

5.3.1 Introduction

This section presents a summary of the SAMA evaluation for DAEC conducted by FPL-DA and the Staff's review of that evaluation. The Staff performed its review with contract assistance from Information Systems Laboratories. The Staff's review is available in full in Appendix G; the SAMA evaluation is available in full in FPL-DA's ER.

The SAMA evaluation for DAEC was conducted with a four-step approach. In the first step, FPL-DA quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic risk assessment (PRA) and other risk models.

In the second step, FPL-DA examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. FPL-DA identified 166 potential SAMAs for DAEC. FPL-DA performed an initial screening to determine if any SAMAs could be eliminated because they are not applicable to DAEC due to design differences, have already been implemented at DAEC, are similar in nature and could be combined with another SAMA candidate, or have excessive implementation cost. This screening reduced the list of potential SAMAs to 24.

In the third step, FPL-DA estimated the benefits and costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC, 1997). The cost of implementing the proposed SAMAs was also estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost benefit). FPL-DA concluded in its ER that several of the SAMAs evaluated are potentially cost-beneficial (FPL-DA, 2008).

FPL-DA's SAMA analyses and the Staff's review are discussed in more detail below.

5.3.2 Estimate of Risk

FPL-DA submitted an assessment of SAMAs for DAEC as part of the ER (FPL-DA, 2008). This assessment was based on the most recent DAEC PRA available at that time; a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the DAEC Individual Plant Examination (IPE) (IELP, 1992) and Individual Plant Examination of External Events (IPEEE) (IES, 1995).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 1.08×10^{-5} per year (see Appendix G for details). The CDF value is based on the risk assessment for internally-initiated events. FPL-DA did not include the contributions from external events within the DAEC risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 1.57. The breakdown of CDF by initiating event is provided in Table 5-2 (see Appendix G.2 for details).

Table 5-2. Duane Arnold Energy Center Core Damage Frequency for Internal Events

Initiating Event	CDF (per year)	% Contribution to CDF
Loss of Offsite Power	4.0 × 10–6	37
Turbine Trip with Bypass	1.6 × 10–6	15
Main Steam Isolation Valve (MSIV) Closure	1.4 × 10–6	13
Inadvertent Open Relief Valve	1.2 × 10–6	11
Loss of Condenser Vacuum	5.9 × 10–7	6
Div 2 125 Volt DC Bus Failure	3.2 × 10–7	3
Manual shutdown	2.8 × 10–7	3
Loss of River Water Supply	2.8 × 10–7	3
Small loss of coolant accident (LOCA)	2.7 × 10–7	3
Loss of Feedwater	2.5 × 10–7	2
Medium LOCA	1.9 × 10–7	2
Div 1 125 Volt DC Bus Failure	1.3 × 10–7	1
Others (less than 1 percent each)	2.8 × 10–7	3
Total CDF (internal events)	**1.08 × 10–5**	**100**

As shown in this table, events initiated by loss of offsite power and other transients (e.g., turbine trip, MSIV closure, and inadvertent open of relief valve) are the dominant contributors to the CDF.

FPL-DA estimated the dose to the population within 50 miles (80 km) of the DAEC site to be approximately 0.198 person-sievert (Sv) (19.8 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-3. Releases from the containment within the early timeframe (0 to less than 6 hours following event initiation) dominate the population dose risk at DAEC.

Table 5-3. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem[1] Per Year)	% Contribution
Early Releases (< 6 hrs)	14.1	71
Intermediate Releases (6 to <24 hrs)	4.2	21

Late Releases (≥ 24 hrs)	1.5	8
Total	**19.8**	**100**

[1]One person-rem = 0.01 person-Sv

The Staff reviewed FPL-DA's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the Staff based its assessment of offsite risk on the CDFs and offsite doses reported by FPL-DA.

5.3.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, FPL-DA searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, FPL-DA considered insights from the plant-specific PRA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. FPL-DA identified 166 potential risk-reducing improvements (i.e., SAMAs) to plant components, systems, procedures, and training.

FPL-DA removed all but 24 of the SAMAs from further consideration because they are not applicable at DAEC due to design differences, have already been implemented at DAEC, are similar in nature and could be combined with another SAMA candidate, or have excessive implementation cost. A detailed cost-benefit analysis was performed for each of the remaining SAMAs.

The Staff concludes that FPL-DA used a systematic and comprehensive process for identifying potential plant improvements for DAEC, and that the set of potential plant improvements identified by FPL-DA is reasonably comprehensive and, therefore, acceptable.

5.3.4 Evaluation of Risk Reduction and Costs of Improvements

FPL-DA evaluated the risk-reduction potential of the remaining 24 SAMAs. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement.

FPL-DA estimated the costs of implementing the candidate SAMAs through the application of engineering judgment, use of other licensee's estimates for similar improvements, and the use of DAEC actual experience for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles.

The Staff reviewed FPL-DA's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the Staff based its estimates of averted risk for the various SAMAs on FPL-DA's risk reduction estimates.

The Staff reviewed the bases for the applicant's cost estimates. For certain improvements, the Staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensee's analyses of SAMAs for operating reactors and advanced light-water reactors. The Staff found the cost estimates to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The Staff concludes that the risk reduction and the cost estimates provided by FPL-DA are sufficient and appropriate for use in the SAMA evaluation.

5.3.5 Cost-Benefit Comparison

The cost-benefit analysis performed by FPL-DA was based primarily on NUREG/BR-0184 (NRC, 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed: one at 3 percent and the other at 7 percent (NRC, 2004). FPL-DA provided both sets of estimates (FPL-DA, 2008).

FPL-DA identified two potentially cost-beneficial SAMAs in the baseline analysis contained in the ER. The potentially cost-beneficial SAMAs are:

- SAMA 156 – Provide an alternate source of water for the residual heat removal service water (RHRSW)/emergency service water (ESW) pit.
- SAMA 166 – Increase the reliability of the low pressure emergency core cooling system (ECCS) reactor pressure vessel (RPV) low pressure permissive circuitry. Install manual bypass of low pressure permissive.

FPL-DA performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (FPL-DA, 2008; NextEra, 2009). If the benefits are increased by an additional factor of 2.5 to account for uncertainties, one additional SAMA candidate was determined to be potentially cost-beneficial:

- SAMA 117 – Increase boron concentration in the boron storage tank.

FPL-DA indicated that they plan to further evaluate these SAMAs for possible implementation, and have included these items in FPL-DA's corrective action program (FPL-DA, 2008; NextEra, 2009).

The Staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.3.6 Conclusions

The Staff reviewed FPL-DA's analysis and concluded that the methods used and the implementation of those methods are sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by FPL-DA are reasonable and sufficient for the license renewal submittal.

Based on its review of the SAMA analysis, the Staff concurs with FPL-DA's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all, or a subset, of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the Staff considers that further evaluation of these SAMAs by FPL-DA is warranted. The staff considered the mitigating benefits of implementing the SAMAs. However, none of the SAMAs listed above are specifically related to an aging management review conducted under the license renewal safety review pursuant to 10 CFR Part 54. The applicant has not made a final determination to implement these SAMAs.

5.4 REFERENCES

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, SOLID WASTE MANAGEMENT, AND GREENHOUSE EMISSIONS

6.1 THE URANIUM FUEL CYCLE

This section addresses issues related to the uranium fuel cycle and solid waste management during the period of extended operation. The uranium cycle includes 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. The Generic Environmental Impact Statement (GEIS) (NRC 1996, 1999) details the potential generic impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle including transportation of nuclear fuel and wastes. The GEIS is based, in part, on the generic impacts provided in Table S-3, “Table of Uranium Fuel Cycle Environmental Data,” in Title 10 of the *Code of Federal Regulations* (CFR), Section 51.51(a), and in Table S-4, “Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor,” in 10 CFR 51.52(b). The GEIS also addresses the impacts from radon-222 and technetium-99.

For these Category 1 issues, the GEIS concludes that the impacts are designated as SMALL, except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal where no significance level was assigned to these two impacts. For the collective offsite radiological impacts, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. The staff of the U.S. Nuclear Regulatory Commission (NRC) did not identify any new and significant information related to the uranium fuel cycle during the review of Nebraska Public Power District’s (NPPD) environmental report (ER) (NPPD, 2008), the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

Nine generic issues are related to the fuel cycle and solid waste management. These are shown in Table 6-1. There are no site-specific issues.

Table 6-1. Issues Related to the Uranium Fuel Cycle and Solid Waste Management

Issues	GEIS Section	Category
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1, 6.2.1, 6.2.2.1, 6.2.2.3, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (collective effects)	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1
Nonradiological impacts of the uranium fuel cycle	6.1, 6.2.2.6, 6.2.2.7, 6.2.2.8, 6.2.2.9, 6.2.3, 6.2.4, 6.6	1
Low-level waste storage and disposal	6.1, 6.2.2.2, 6.4.2, 6.4.3, 6.4.3.1, 6.4.3.2, 6.4.3.3, 6.4.4, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.4.4, 6.4.4.5, 6.4.4.5.1, 6.4.4.5.2, 6.4.4.5.3, 6.4.4.5.4, 6.4.4.6, 6.6	1
Mixed waste storage and disposal	6.4.5.1, 6.4.5.2, 6.4.5.3, 6.4.5.4, 6.4.5.5, 6.4.5.6, 6.4.5.6.1, 6.4.5.6.2, 6.4.5.6.3, 6.4.5.6.4, 6.6	1
Onsite spent fuel	6.1, 6.4.6, 6.4.6.1, 6.4.6.2, 6.4.6.3, 6.4.6.4, 6.4.6.5, 6.4.6.6, 6.4.6.7, 6.6	1
Nonradiological waste	6.1, 6.5, 6.5.1, 6.5.2, 6.5.3, 6.6	1
Transportation	6.1, 6.3.1, 6.3.2.3, 6.3.3, 6.3.4, 6.6, Addendum 1	1

6.2 GREENHOUSE GAS EMISSIONS

This section provides a discussion of potential impacts from greenhouse gases (GHGs) emitted from the nuclear fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are implemented.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear power lifecycle vary depending on the type of study conducted. Additionally, considerable debate also exists among researchers regarding the relative impacts of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(1) Qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming; and

(2) Technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant life cycle and comparisons to the operational or life cycle emissions from other energy generation alternatives.

Some of these studies are summarized below to give the reader an overview of the current state of these assessments.

6.2.1.1 *Qualitative Studies*

The qualitative studies consist primarily of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies include:

- Evaluations to determine whether investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider, 2000; IAEA, 2000; NEA, 2002; NIRS/WISE, 2005). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the Clean Development Mechanism (CDM) due to safety and waste disposal concerns (NEA, 2002).

- Analyses developed to assist governments, including the United States, in making long-term investment and public policy decisions in nuclear power (Keepin, 1988; Hagen et al., 2001; MIT, 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or life cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 *Quantitative Studies*

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature and were useful to the NRC staff's efforts in addressing relative GHG emission levels. Examples of these studies include – but are not limited to – Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), Atomic Energy Authority (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include:

- Energy sources that may be used to mine uranium deposits in the future;
- Reprocessing or disposal of spent nuclear fuel;
- Current and potential future processes to enrich uranium and the energy sources that will power them;
- Estimated grades and quantities of recoverable uranium resources;
- Estimated grades and quantities of recoverable fossil fuel resources;
- Estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced;
- Performance of future fossil fuel power systems;
- Projected capacity factors for alternatives means of generation; and
- Current and potential future reactor technologies.

In addition, studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed, i.e., a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning, whereas, a partial lifecycle analysis primarily focus on operational differences.

In the case of license renewal a GHG analysis for that portion of the plant's lifecycle (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. However, in some of the aforementioned studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. Nonetheless, these studies provide some meaningful information with respect to the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6-2, 6-3, and 6-4 the NRC staff presents the results of the aforementioned quantitative studies to provide a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward suggest that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies indicate that the relatively lower order of magnitude of GHG emissions from nuclear power when compared to fossil-fueled alternatives (especially natural gas) could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the United States and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation, including Duane Arnold Energy Center (DAEC), most of the available quantitative studies focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent coal-fired plant, are presented in Table 6-2. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

Table 6-2. Nuclear Greenhouse Gas Emissions Compared to Coal

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Coal—264 to 357 g Ceq/kWh
Storm van Leeuwen and Smith (2005)	Authors did not evaluate nuclear versus coal.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Coal—950 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Coal—>1000 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq /kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Coal—950 to 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones (2007)	Author did not evaluate nuclear versus coal.

Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent natural gas-fired plant, are presented in Table 6-3. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

Table 6-3. Nuclear Greenhouse Gas Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer (1990)	Author did not evaluate nuclear versus natural gas.
Andseta (1998)	Author did not evaluate nuclear versus natural gas.
Spadaro (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Natural Gas—120 to 188 g Ceq/kWh
Storm van Leeuwen and Smith (2005)	Nuclear fuel cycle produces 20 to 33 percent of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Cogeneration Combined Cycle Natural Gas—150 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Natural Gas—500 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90 percent.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Natural Gas—440 to 780 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones (2007)	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15 to 27 percent of the GHG emissions of natural gas.

Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies due to their different sources and locations. For example, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

Table 6-4. Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta (1998)	Author did not evaluate nuclear versus renewable energy sources.
Spadaro (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Solar PV—27.3 to 76.4 g Ceq/kWh Hydroelectric—1.1 to 64.6 g Ceq/kWh Biomass—8.4 to 16.6 g Ceq/kWh Wind—2.5 to 13.1 g Ceq/kWh
Storm van Leeuwen and Smith (2005)	Author did not evaluate nuclear versus renewable energy sources.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Solar PV—125 g Ceq/kWh Hydroelectric—50 g Ceq/kWh Wind—20 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Biomass—25 to 93 g Ceq/kWh Solar PV—35 to 58 g Ceq/kWh Wave/Tidal—25 to 50 g Ceq/kWh Hydroelectric—5 to 30 g Ceq/kWh Wind—4.64 to 5.25 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq/kWh.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Solar PV—43 to 73 g Ceq/kWh Hydroelectric—1 to 34 g Ceq/kWh Biomass—35 to 99 g Ceq/kWh Wind—8 to 30 g Ceq/kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g Ceq/kWh Solar PV—17 to 49 g Ceq/kWh

Source	GHG Emission Results
Dones (2007)	Author did not evaluate nuclear versus renewable energy sources.

6.2.2 Conclusions: Relative GHG Emissions

The sampling of data presented in Tables 6-2, 6-3, and 6-4 above demonstrates the challenges of any attempt to determine the specific amount of GHG emission attributable to nuclear energy production sources, as different assumptions and calculation methodology will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they're used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies indicate a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation, e.g., the GHG emissions from a complete nuclear fuel cycle currently range from 2.5 to 55 g C_{eq}/kWh, as compared to the use of coal plants (264 to 1250 g C_{eq}/kWh) and natural gas plants (120 to 780 g C_{eq}/kWh). The studies also provide estimates of GHG emissions from five renewable energy sources based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is wide, but the general conclusion is that current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as from these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and is expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed DAEC relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the following rationale:

1. As shown in Tables 6-2 and 6-3, the current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources;

2. DAEC license renewal will involve continued GHG emissions due to uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not); and

3. Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the DAEC period of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions among the proposed DAEC license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities of all types. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same order of magnitude. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power, and because most renewable energy sources lack a fuel component, it is likely that GHG emissions from renewable energy sources would be lower than those associated with DAEC at some point during the period of extended operation.

The NRC staff also provides an additional discussion about the contribution of GHG to cumulative air quality impacts in Section 4.11.2 of this SEIS,

6.3 REFERENCES

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 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating 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."

40 CFR Part 191. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

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Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

Weisser, D. 2006. "A Guide to Life-Cycle Greenhouse Gas (GHG) Emissions from Electric Supply Technologies." Available URL: http://www.iaea.org/OurWork/ST/NE/Pess/assets/GHG_manuscript_pre-print_versionDanielWeisser.pdf (accessed May 19, 2009)

7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002). The staff's evaluation of the environmental impacts of decommissioning, presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).

7.1 DECOMMISSIONING

Category 1 issues in Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B that are applicable to Duane Arnold Energy Center (DAEC) decommissioning following the renewal term are listed in Table 7-1.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of DAEC Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

A brief description of the Staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of the issues follows:

- <u>Radiation doses</u>. Based on information in the GEIS, the Commission found that:

    Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.

- Waste management. Based on information in the GEIS, the Commission found that:

  Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

- Air quality. Based on information in the GEIS, the Commission found that:

  Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

- Water quality. Based on information in the GEIS, the Commission found that:

  The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

- Ecological resources. Based on information in the GEIS, the Commission found that:

  Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found that:

  Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

The NRC staff has not identified any new and significant information during the review of the FPL Energy Duane Arnold, LLC (FPL-DA) environmental report (ER) (NPPD, 2008), the site audit, or the scoping process; therefore, there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996, 1999). For the issues listed in Table 7-1 above, the GEIS concluded that the impacts are SMALL.

7.2 REFERENCES

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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U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3, Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) mandates that each environmental impact statement (EIS) consider alternatives to any proposed major Federal action significantly affecting the quality of the human environment. U.S. Nuclear Regulatory Commission (NRC) regulations implementing NEPA for license renewal require that a supplemental environmental impact statement (SEIS) consider and weigh " the environmental effects of the proposed action (license renewal); the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental impacts," (Title 10 of the *Code of Federal Regulations* (CFR) 51.71d).

This SEIS considers the proposed Federal action of issuing a renewed license for the Duane Arnold Energy Center (DAEC), which would allow the plant to operate for 20 years beyond its current license expiration date. In this chapter, the NRC staff (Staff) examines the potential environmental impacts of alternatives to issuing a renewed operating license for DAEC, as well as alternatives that may reduce or avoid adverse environmental impacts from license renewal, when and where these alternatives are applicable.

While the *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants*, NUREG-1437 (NRC 1996, 1999), reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the Staff must evaluate environmental impacts of alternatives on a site-specific basis.

Alternatives to the proposed action of issuing a renewed DAEC operating license must meet the purpose and need for issuing a renewed license; they must

> provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision makers.

The Staff ultimately makes no decision as to which alternative (or the proposed action) to implement, since that decision falls to utility, State, or other Federal officials to decide. Comparing the environmental effects of these alternatives will assist the Staff in deciding whether the environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable (10 CFR 51.95[c][4]). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy-planning decision-makers. If NRC decides not to renew the license (or takes no action at all), then energy-planning decision-makers may no longer elect to continue operating DAEC and will have to resort to another alternative—which may or may not be one of the alternatives considered in this section—to meet their energy needs.

In evaluating alternatives to license renewal, the Staff first selects energy technologies or options currently in commercial operation as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current DAEC operating license expires. The current DAEC operating license will expire on February 21, 2014, and an alternative must be available (constructed, permitted, and connected to the grid) by the time the current DAEC license expires.

Second, the Staff screens the alternatives to remove those that cannot meet future system needs, and then screens the remaining options to remove those whose costs or benefits do not justify inclusion in the range of reasonable alternatives. Any alternatives remaining, then, constitute alternatives to the proposed action that the Staff evaluates in detail throughout this section. In Section 8.4, the SEIS briefly addresses each alternative that the Staff removed during screening and explains why each alternative was removed.

The Staff initially considered 17 discrete potential alternatives to the proposed action, and then narrowed the list to the two discrete alternatives and one combination alternative considered in sections 8.1 through 8.3.

Once the Staff identifies alternatives for in-depth review, the Staff refers to generic environmental impact evaluations in the GEIS. The GEIS provides overviews of some energy technologies available at the time of its publishing in 1996, though it does not reach any conclusions regarding which alternatives are most appropriate, nor does it precisely categorize impacts for each site. In addition, since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the Staff's analyses starts with the GEIS and then includes updated information from sources like the Energy Information Administration (EIA), other organizations within the Department of Energy (DOE), the Environmental Protection Agency (EPA), industry sources and publications, and information submitted in the applicant's (FPL Energy Duane Arnold, LLC [FPL-DA]) environmental report (ER).

In-Depth Alternatives:

- **Coal-fired supercritical**
- **Natural gas-fired combined-cycle**
- **Combination**

Other Alternatives Considered:

- **Coal-fired integrated gasification combined-cycle (IGCC)**
- **New nuclear**
- **Wind power**
- **Conservation**
- **Purchased power**
- **Solar power (photovoltaic and concentrating)**
- **Wood-fired combustion**
- **Conventional hydroelectric power**
- **Wave and ocean energy**
- **Geothermal power**
- **Municipal solid waste**
- **Biofuels**
- **Methane**
- **Oil-fired power**
- **Fuel cells**
- **Delayed retirement**

For each in-depth analysis, the Staff analyzes environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) biological, (5) human health, (6) socioeconomics, and (7) waste management. As in earlier chapters of this draft SEIS, the Staff uses the NRC's three-level standard of significance—

SMALL, MODERATE, or LARGE—to indicate the degree of the environmental effect on each of the seven aforementioned categories that have been evaluated.

The in-depth alternatives that the Staff considered include a supercritical coal-fired plant in section 8.1, a natural gas-fired combined-cycle power plant in 8.2, and a combination of alternatives in 8.3, that includes some natural gas-fired capacity, energy conservation, and a wind power component. In section 8.4, the Staff explains why it dismissed many other alternatives from in-depth consideration. Finally, in section 8.5, the Staff considers the environmental effects that may occur if NRC takes no action and does not issue a renewed license for DAEC.

> **Energy Outlook:** Each year the Energy Information Administration (EIA), part of the U.S. Department of Energy (DOE), issues its updated *Annual Energy Outlook (AEO)*. *AEO 2009* indicates that natural gas, coal, and renewable are likely to fuel most new electrical capacity through 2030, with some growth in nuclear capacity (EIA, 2009a), though all projections are subject to future developments in fuel price or electricity demand:
>
> "Natural-gas-fired plants account for 53 percent of capacity additions in the reference case, as compared with 22 percent for renewable, 18 percent for coal-fired plants, and 5 percent for nuclear Capacity expansion decisions consider capital, operating, and transmission costs. Typically, coal-fired, nuclear, and renewable plants are capital-intensive, whereas operating (fuel) expenditures account for most of the costs associated with natural-gas-fired capacity."

8.1 SUPERCRITICAL COAL-FIRED GENERATION

The GEIS indicates that a 610 megawatt-electric (MWe) supercritical coal-fired power plant (a plant equivalent in capacity to DAEC) could require 1,040 acres (421 hectares [ha]) and thus would not fit on the existing DAEC site; however, the Staff notes that many coal-fired power plants with larger capacities have been located on smaller sites. In the ER, FPL-DA also indicated that onsite construction of a coal-fired alternative would be preferred over an offsite location. The Staff believes this to be reasonable and, as such, will consider a coal-fired alternative located on the current DAEC site.

Coal-fired generation accounts for a greater share of U.S. electrical power generation than any other fuel (EIA, 2009b). Furthermore, the EIA projects that coal-fired power plants will account for the greatest share of added capacity through 2030—more than natural gas, nuclear or renewable generation options. While coal-fired power plants are widely used and likely to remain widely used, the Staff notes that future coal capacity additions may be affected by perceived or actual efforts to limit greenhouse gas (GHG) emissions. For now, the Staff considers a coal-fired alternative to be a feasible, commercially available option that could provide electrical generating capacity after DAEC's current license expires.

Supercritical technologies are increasingly common in new coal-fired plants. Supercritical plants operate at higher temperatures and pressures than most existing coal-fired plants (beyond water's "critical point", where boiling no longer occurs and no clear phase change occurs between steam and liquid water). Operating at higher temperatures and pressures allows this coal-fired alternative to function at a higher thermal efficiency than many existing coal-fired power plants do. While supercritical facilities are more expensive to construct, they consume less fuel for a given output, reducing environmental impacts. Based on technology forecasts from EIA, the Staff expects that a new, supercritical coal-fired plant beginning operation in 2014 would operate at a heat rate of 9069 British thermal units/kilowatt hour (Btu/kWh), or approximately 38 percent thermal efficiency (EIA, 2009a).

In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam/water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser.

In most modern U.S. facilities, condenser cooling water circulates through cooling towers or a cooling pond system (either of which are closed-cycle cooling systems). Older plants often withdraw cooling water directly from existing rivers or lakes and discharge heated water directly to the same body of water (called open-cycle cooling). In this case, a coal-fired alternative constructed on the Duane Arnold site would withdraw makeup water from and discharge blowdown (water containing concentrated dissolved solids and biocides) from cooling towers back to the Cedar River. Because DAEC already utilizes two mechanical draft cooling towers onsite, the coal-fired alternative would likely use these existing cooling towers for its closed-cycle cooling system. Because nuclear plants require more cooling capacity than the equivalently sized coal-fired plant, the existing cooling towers are expected to be adequate to support a coal-fired alternative without amendment or expansion. A coal-fired alternative may also make use of the existing river intake and discharge towers if such a retrofit can take place while DAEC continues operating.

In order to replace the 610 net MWe that DAEC currently supplies, the coal-fired alternative would need to produce roughly 575 net MWe, using about 6 percent of power output for onsite power usage (FPL-DA, 2008). Onsite electricity demands include scrubbers, cooling towers, coal-handling equipment, lights, communication, and other onsite needs. A supercritical coal-fired plant equivalent in capacity to DAEC would require less cooling water than DAEC because the alternative operates at a higher thermal efficiency.

This 610 MWe power plant would consume 2.25 million tons (2.04 million metric tons (MT)) of coal annually assuming an average heat content of 8,668 British Thermal Units per pound (btu/lb) (EIA, 2006). EIA reported that most coal consumed in Iowa originates in Wyoming. Given current coal mining operations in the state of Wyoming, the coal used in this alternative would likely be mined in surface mines, then mechanically processed and washed, before being transported—via an existing rail spur—to the power plant site. Limestone for scrubbers would also arrive by rail. This coal-fired alternative would produce roughly 116,800 tons (106,000 MT) of ash, and roughly 47,300 tons (43,000 MT) scrubber sludge annually. As noted above, much of the coal ash and scrubber sludge could be reused depending on local recycling and reuse markets.

The coal-fired alternative would also include construction impacts such as clearing the plant site of vegetation, excavation, and preparing the site surface before other crews begin actual construction of the plant and any associated infrastructure. Because this alternative would be constructed at the DAEC site, it is unlikely that new transmission lines or a new rail spur would be necessary.

Table 8-1. Summary of Environmental Impacts of the Supercritical Coal-Fired Alternative Compared to Continued Operation of Duane Arnold Energy Center

	Supercritical Coal-Fired Generation	Continued DAEC Operation
Air Quality	MODERATE	SMALL
Groundwater	SMALL	SMALL to MODERATE
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to MODERATE
Waste Management	MODERATE	SMALL

8.1.1 Air Quality

Air quality impacts from coal-fired generation can be substantial increased because they emit significant quantities of sulfur oxides (SOx), nitrogen oxides (NOx), particulates, carbon monoxide (CO), and hazardous air pollutants such as mercury. However, many of these pollutants can be substantially reduced using various pollution control technologies.

DAEC is located in Linn County, Iowa. There are no areas designated by the EPA as nonattainment or maintenance for any of the criteria pollutants in the 50-mile (81-km) vicinity of DAEC. A new coal-fired generating plant would qualify as a new major-emitting industrial facility and would be subjected to Prevention of Significant Deterioration of Air Quality Review under requirements of Clean Air Act (CAA), adopted by Iowa Department of Natural Resources (IDNR) Air Quality Bureau in Section 567 of the Iowa Administrative Code (IAC) (IDNR, 2008). A new coal-fired generating plant would need to comply with the new source performance standards for coal-fired plants set forth in 40 CFR 60 Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), sulfur dioxide (SO_2) (40 CFR 60.43(a)), and NOx (40 CFR 60.44(a)). Regulations issued by IDNR adopt the EPA's CAA rules (with modifications) to limit power plant emissions of SOx, NOx, particulate matter, and hazardous air pollutants. The new coal-fired generating plant would qualify as a Class I major source as identified in Section 567 of the IAC and would be required to obtain Class I major source permits from IDNR, which the EPA may also elect to review prior to issuance of the permits (IDNR, 2008).

Section 169A of the CAA (42 *United States Code* (U.S.C.) 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. The EPA issued a new regional haze rule in 1999 (64 *Federal Register* (FR) 35714). The rule specifies that for each mandatory Class I Federal area located within a state, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide an improvement in visibility for the most-impaired days over the period of implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). Five regional planning organizations (RPO) collaborate on the visibility impairment issue, developing the technical basis for these plans. The State of Iowa is among nine member states (Iowa, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Missouri, Arkansas, and Louisiana) of the Central Regional Air Planning Association (CENRAP), along with tribes, Federal agencies, and other interested parties that identifies regional haze and visibility issues and develops strategies to address them. The visibility protection regulatory requirements, contained in 40 CFR Part 51, Subpart P, include the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area (40 CFR Part 51, Subpart P, §51.307). If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. There are no mandatory Class I Federal areas in the State of Iowa and the closest mandatory Class I Federal area is Mingo Wilderness Area, which is located 365 miles southeast from the DAEC in the State of Missouri.

Iowa is also subject to the Clean Air Interstate Rule (CAIR), which has outlined emissions reduction goals for both SO_2 and NOx for the year 2015. CAIR will aid Iowa sources in reducing SO_2 emissions by 7,000 tons (or 5 percent), and NOx emissions by 37,000 tons (or 49 percent). (EPA, 2008b).

The Staff projects that the coal-fired alternative at the DAEC site would have the following emissions for criteria and other significant emissions based on published EIA data, EPA emission factors and on performance characteristics for this alternative and likely emission controls:

- Sulfur oxides (SOx) – 898.19 tons (814.83 MT) per year
- Nitrogen oxides (NOx) – 562.77 tons (510.55 MT) per year
- Total suspended particles (TSP) – 99.76 tons (90.50 MT) per year
- Particulate matter (PM) PM_{10} – 22.95 tons (20.82 MT) per year
- Particulate matter (PM) $PM_{2.5}$ – 58.42 tons (52.99 MT) per year
- Carbon monoxide (CO) – 562.77 tons (510.55 MT) per year

8.1.1.1 Sulfur Oxides

The coal-fired alternative at the DAEC site would likely use wet, limestone-based scrubbers to remove SOx. The EPA indicates that this technology can remove more than 95 percent of SOx from flue gases. The Staff projects total SOx emissions after scrubbing would be 898.19 tons

(814.83 MT) per year. SOx emissions from a new coal-fired power plant would be subject to the requirements of Title IV of the CAA. Title IV was enacted to reduce emissions of SO_2 and NOx, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. The EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore purchase allowances from owners of other power plants or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, provided a new coal-fired power plant is able to purchase sufficient allowances to operate, it would not add to net regional SO_2 emissions, although it might do so locally.

8.1.1.2 Nitrogen Oxides

A coal-fired alternative at the DAEC site would most likely employ various available NOx-control technologies, which can be grouped into two main categories: combustion modifications and post-combustion processes. Combustion modifications include low-NOx burners, over fire air, and operational modifications. Post-combustion processes include selective catalytic reduction and selective non-catalytic reduction. An effective combination of the combustion modifications and post-combustion processes allow the reduction of NOx emissions by up to 95 percent (EPA, 1998). FPL-DA indicated in its ER that it would use a combination of low-NOx burners, overfire air, and selective catalytic reduction technologies to reduce NOx emissions from this alternative. Assuming the use of such technologies at the DAEC site, NOx emissions after scrubbing are estimated to be 562.77 tons (510.55 MT) annually.

Section 407 of the CAA establishes technology-based emission limitations for NOx emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants as indicated in 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49453), limits the discharge of any gases that contain nitrogen oxides (NO2) to 200 nanograms (ng) of NOx per joule (J) of gross energy output (equivalent to 1.6 lb/MWh), based on a 30-day rolling average. Based on the projected emissions, the proposed alternative would easily meet this regulation.

8.1.1.3 Particulates

The new coal-fired power plant would use fabric filters to remove particulates from flue gases. FPL-DA indicates that fabric filters would remove 95 percent of particulate matter (FPL-DA, 2008). The EPA notes that filters are capable of removing in excess of 99 percent of particulate matter, and that SO_2 scrubbers further reduce particulate matter emissions (EPA, 2008a). Based on EPA emission factors, the new supercritical coal-fired plant would emit 99.76 tons (90.50 MT) per year and approximately 22.95 tons (20.82 MT) per year of particulate matter having an aerodynamic diameter less than or equal to 10 microns (PM_{10}) annually (EPA, 2009e). In addition, coal burning would also result in approximately 58.42 tons (52.99 MT) per year of particulate emissions with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). Coal-handling equipment would introduce fugitive dust emissions when fuel is being transferred to onsite storage and then reclaimed from storage for use in the plant. During the construction of a coal-fired plant, onsite activities would also generate fugitive dust. Vehicles and motorized equipment would create exhaust emissions during the construction process. These impacts would be intermittent and short-lived, however, and to minimize dust generation construction crews would use applicable dust-control measures.

8.1.1.4 Carbon Monoxide

Based on EPA emission factors (EPA, 1998). Based on these emission factors and assumed plant characteristics, the Staff computed that the total CO emissions would be approximately 562.77 tons (510.55 MT) per year.

8.1.1.5 Hazardous Air Pollutants

Consistent with the D.C. Circuit Court's February 8, 2008 ruling that vacated its Clean Air Mercury Rule (CAMR), the EPA is in the process of developing mercury emissions standards for power plants under the CAA (Section 112) (EPA, 2009 at 3). Before CAMR, the EPA determined that coal-and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants (HAPs) (EPA, 2000b). The EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA, 2000b). The EPA concluded that mercury is the HAP of greatest concern; it further concluded that:

(1) a link exists between coal combustion and mercury emissions

(2) electric utility steam-generating units are the largest domestic source of mercury emissions, and

(3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (EPA, 2000b).

On February 6, 2009, the Supreme Court dismissed the EPA's request to review the 2008 Circuit Court's decision, and also denied a similar request by the Utility Air Regulatory Group later that month (EPA, 2009 at 3).

8.1.1.6 Carbon Dioxide

A coal-fired plant would also have unregulated carbon dioxide (CO_2) emissions during operations as well as during mining, processing, and transportation, which the GEIS indicates could contribute to global warming. The coal-fired plant would emit between 4,123,000 tons (3,741,000 MT) and 4,272,000 tons (3,876,600 MT) of CO_2 per year, depending on the type and quality of the coal burned.

8.1.1.7 Summary of Air Quality

While the GEIS analysis mentions global warming from unregulated CO_2 emissions and acid rain from SOx and NOx emissions as potential impacts, it does not quantify emissions from coal-fired power plants. However, the GEIS analysis does imply that air impacts would be substantial (NRC, 1996). The above analysis shows that emissions of air pollutants, including SOx, NOx, CO, and particulates, exceed those produced by the existing nuclear power plant, as well as those of the other alternatives considered in this section. Operational emissions of CO2 are also much greater under the coal-fired alternative, as reviewed by the Staff in Section 6.2 and in the previous paragraph. Adverse human health effects such as cancer and emphysema have also been associated with air emissions from coal combustion, and are discussed further in Section 8.1.5.

The NRC analysis for a coal-fired alternative at the DAEC site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Therefore, the appropriate characterization of air impacts from coal-fired plant located at DAEC site would be MODERATE. Existing air quality would result in varying needs for pollution control equipment to meet applicable local requirements, or varying degrees of participation in emissions trading schemes.

8.1.2 Groundwater Use and Quality

If the onsite coal-fired alternative continued to use groundwater for drinking water and service water, the need for groundwater at the plant would be minor. Total usage would likely be less than DAEC because many fewer workers would be onsite, and because the coal-fired unit would have fewer auxiliary systems requiring service water. No effect on groundwater quality would be apparent.

Construction of a coal-fired plant could have a localized effect on groundwater due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the coal-fired alternative would be SMALL.

8.1.3 Surface Water Use and Quality

The alternative would draw approximately 9,000 gallons per minute (gpm) from the Cedar River, with an average consumption of about 11 million gallons per day (mgd). This consumptive loss is less than 0.1 percent of the average annual flow of the Cedar River, and as such the NRC concludes the impact of surface water use would be SMALL. A new coal-fired plant would be required to obtain a National Pollutant Discharge and Elimination System (NPDES) permit from the IDNR for regulation of industrial wastewater, storm water, and other discharges. Assuming the plant operates within the limits of this permit, the impact from any cooling tower blowdown, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.1.4 Aquatic and Terrestrial Ecology

8.1.4.1 Aquatic Ecology

The number of fish and other aquatic resource organisms affected by impingement, entrainment, and thermal impacts would be smaller than that associated with license renewal because water consumption from and blowdown to the Cedar River would be lower. Some temporary impacts to aquatic organisms might occur due to any construction that might occur or due to any effluent discharges to the river, but these activities would be monitored by the IDNR under the project's NPDES permit. Although the number of affected organisms would be less than for license renewal, the NRC level of impact for license renewal is already small, and so

NRC expects that the levels of impact for impingement, entrainment, and thermal effects would also be SMALL for this alternative.

8.1.4.2 Terrestrial Ecology

As indicated in the applicant's ER, constructing the coal-fired alternative onsite would require less than 96 acres (39 ha) of land (FPL-DA, 2008). Coal-mining would also affect terrestrial ecology in offsite coal mining areas, although some of the land is likely already disturbed by mining operations. Onsite and offsite land disturbances form the basis for impacts to terrestrial ecology.

Onsite impacts to terrestrial ecology would be minor because most of the site has been previously disturbed and is currently used for agricultural activities. This could change if additional roads would need to be constructed through less disturbed areas. These construction activities may fragment or destroy habitats and could include a loss of onsite farmland. These land disturbances could affect food supply and habitat of native wildlife and migratory waterfowl, however, these impacts are not expected to be significant. Cooling tower operation could produce a visible plume as well as some deposition of dissolved solids on surrounding vegetation and soil from cooling tower drift, however, the GEIS indicated that the impact of cooling towers on agricultural crops is relatively small, and most of the land surrounding the DAEC site is farmland.

Any onsite or offsite waste disposal by landfilling would also affect terrestrial ecology at least through the period when the disposal area is reclaimed. Deposition of acid rain resulting from NOx or SOx emissions, as well as the deposition of other pollutants, can also affect terrestrial ecology. Given the emission controls discussed in Section 8.1.1, air deposition impacts may be noticeable, but are not likely to be destabilizing. Primarily because of the potential habitat disturbances, impacts to terrestrial resources from a coal-fired alternative would be SMALL to MODERATE, and would occur mostly during construction.

8.1.5 Human Health

Coal-fired power plants introduce worker risks from coal and limestone mining, from coal and limestone transportation, and from disposal of coal combustion and scrubber wastes. In addition, there are public risks from inhalation of stack emissions (as addressed in Section 8.1.1) and the secondary effects of eating foods grown in areas subject to deposition from plant stacks.

Human health risks of coal-fired power plants are described, in general, in Table 8-2 of the GEIS (NRC, 1996). Cancer and emphysema as a result of the inhalation of toxins and particulates are identified as potential health risks to occupational workers and members of the public (NRC, 1996). The human health risks of coal-fired power plants, both to occupational workers and to members of the public, are greater than those of the current DAEC due to exposures to chemicals such as mercury; SOx; NOx; radioactive elements such as uranium and thorium contained in coal and coal ash; and polycyclic aromatic hydrocarbon (PAH) compounds, including benzo(a)pyrene.

Regulations restricting emissions—enforced by EPA or State agencies—have acted to significantly reduce potential health effects but have not entirely eliminated them. These agencies also impose site-specific emission limits as needed to protect human health. Even if the coal-fired alternative were located in a nonattainment area, emission controls and trading or offset mechanisms could prevent further regional degradation; however, local effects could be visible. Many of the byproducts of coal combustion responsible for health effects are largely controlled, captured, or converted in modern power plants (as described in Section 8.1.1), although some level of health effects may remain.

Aside from emission impacts, the coal-fired alternative introduces the risk of coal pile fires and for those plants that use coal combustion liquid and sludge waste impoundments, the release of the waste due to a failure of the impoundment. Although there have been several instances of this occurring in recent years, these types of events are still relatively rare.

Overall, given extensive health-based regulation, the Staff expects human health impacts to be SMALL.

8.1.6 Socioeconomics

8.1.6.1 Land Use

The GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new supercritical coal-fired power plant on the DAEC site.

FPL-DA indicated that approximately 96 acres (39 ha) of land would be needed to support a coal-fired alternative capable of replacing the DAEC. This amount of land use includes power plant structures and associated coal delivery and waste disposal infrastructure. FPL-DA indicated that the site has an existing rail spur, however an additional 100 acres (40 ha) of land area may be needed for waste disposal, which FPL-DA indicated could be accommodated onsite (FPL-DA, 2008).

Offsite land use impacts would occur from coal mining in addition to land use impacts from the construction and operation of the new power plant. Scaling from GEIS estimates, approximately 13,450 acres (5,450 ha) of land could be affected by mining coal and waste disposal to support the coal-fired alternative during its operational life (NRC, 1996). However, most of the land in existing coal-mining areas has already experienced some level of disturbance. The elimination of the need for uranium mining to supply fuel for the DAEC would partially offset this offsite land use impact. Scaling from GEIS estimates, approximately 610 acres (247 ha) of land would be used for uranium mining and processing would no longer be needed.

Based on this information, land use impacts could range from SMALL to MODERATE.

8.1.6.2 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new coal-fired power could affect regional employment, income, and expenditures. Two types of job creation result from this alternative: (1) construction-related jobs, and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. The Staff estimated workforce requirements during power plant construction and operation for the coal-fired alternative in order to measure their possible effect on current socioeconomic conditions.

Based on GEIS estimates, FPL-DA projected a peak construction workforce of 937 to 1,500 workers would be required to construct the coal-fired alternative at the DAEC (FPL-DA, 2008). During the construction period, the communities surrounding the plant site would experience increased demand for rental housing and public services. The relative economic contributions of these relocated workers to local business and tax revenues would vary over time.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services. In addition, the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce would need to relocate closer to the construction site. Although the ER indicates that DAEC is a rural site, it is located near three metropolitan areas: Waterloo (34 miles), Iowa City (32 miles), and Cedar Rapids (5.7 miles). Therefore, these effects may be somewhat lessened because workers are likely to commute to the site from these areas instead of relocating closer to the construction site. Based on the site’s proximity to these metropolitan areas, construction impacts would be SMALL.

FPL-DA estimated an operational workforce of 66 to 150 workers for the 610 MWe alternative based on GEIS estimates (FPL-DA, 2008). The FPL-DA estimate appears reasonable and is consistent with trends calling for decreased workforces at power facilities. Even at a rural site like DAEC, impacts are unlikely to be large. Operational impacts would likely be SMALL.

8.1.6.3 Transportation

During construction, 900 to 1,500 workers would be commuting to the site. In addition to commuting workers, trucks would transport construction materials and equipment to the worksite increasing the amount of traffic on local roads, while trains would transport some of the largest components to the plant site. The increase in vehicular traffic on roads would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Trains would likely be used to deliver large components to the DAEC site given its existing rail spur. Transportation impacts are likely to be MODERATE during construction.

Transportation impacts would be greatly reduced after construction, but would not disappear during plant operations. The maximum number of plant operating personnel commuting to the DAEC would be approximately 150 workers. Frequent deliveries of coal and limestone by rail would add to the overall transportation impact. Onsite coal storage would make it possible to receive several trains per day. Limestone delivered by rail could also add traffic (though considerably less traffic than that generated by coal deliveries).

The coal-fired alternative would likely create SMALL to MODERATE transportation impacts during plant operations.

8.1.6.4 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the coal-fired alternative and the surrounding landscape and the visibility of the coal plant.

The coal-fired alternative would be up to 200 feet (61 m) tall with an exhaust stack up to 500 feet (152 m) and may be visible offsite in daylight hours. The coal-fired plant could therefore be somewhat taller than the current DAEC reactor building, which stands at 140 feet (43 m) with a 328-foot (100-m) offgas stack. The mechanical draft towers would generate a condensate plume, but this would be no more noticeable than the existing DAEC plume. Depending on need, the coal-fired alternative may only require the use of one cooling tower instead of the current two, thus minimizing the size of the condensate plume. Noise and light from plant operations, as well as lighting on plant structures, may be detectable offsite.

Overall, aesthetic impacts associated with the coal-fired alternative would likely be SMALL to MODERATE.

8.1.6.5 Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any proposed areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities. Studies would be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). Areas with the greatest sensitivity should be avoided.

The impact for a coal-fired alternative at the DAEC site would be MODERATE. As noted in Section 4.9.6, potential impacts to historic and archaeological resources could be minimized or avoided if DAEC develops procedures and a cultural resource management plan that effectively consider historic and archaeological resources. This plan would ensure that informed decisions are made prior to any ground disturbing activities onsite. Plant procedures would also include an inadvertent discovery (stop work) provision. Depending on the resource richness of area ultimately chosen for the coal-fired alternative, impacts could be MODERATE.

8.1.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new coal-fired power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group.

According to 2000 census data, 7.6 percent of the population (approximately 49,296 individuals) residing within a 50-mile radius of DAEC were minority individuals. The largest minority group was Black or African American (18,883 individuals, or 2.9 percent), followed by Hispanic (11,772 individuals, or about 1.8 percent). Approximately 6 percent of the Linn County populations are minorities, with Black or African American (2.5 percent) the largest minority group, followed by Hispanic (1.4 percent). In Benton County, 1.2 percent of the populations are minorities, with Hispanic (0.6 percent) the largest minority group, followed by Black or African American (0.2 percent).The 50-mile radius around DAEC consists of each county with at least one census block group located within the 50-mile radius. The population demographic data from these counties were added together to derive average regional percentages. Of the 512 census block groups located wholly or partly within the 50-mile radius of DAEC, 23 block groups were determined to have minority population percentages that exceeded the regional percentages by 20 percentage points or more, or that were more than 50 percent minority. The largest number of minority block groups was Black or African American, with 14 block groups that exceed the regional percentage of 20 percent or more, or that were more than 50 percent Black or African American.

These block groups are concentrated in urban areas with high population densities in Black Hawk County and Linn County. The closest high density minority population to DAEC is located in the city of Cedar Rapids, Iowa. Based on 2000 census data, Figure 4-1 shows minority block groups within a 50-mile radius of DAEC.

According to 2000 census data, 59,848 individuals (approximately 9.2 percent) residing within a 50-mile radius of DAEC were identified as living below the Federal poverty threshold. The 1999 Federal poverty threshold was $17,029 for a family of four. According to Census Bureau data, the median household income for Iowa in 2007 was $47,324, while 11.0 percent of the State population was determined to be living below the 1999 Federal poverty threshold. Linn County had one of the higher median household incomes ($53,076) in the State, and a lower percentage (9.9 percent) of individuals living below the poverty level, when compared to the State.

Census block groups were considered low-income block groups if the percentage of households below the Federal poverty threshold exceeded the State average by 20 percent or more. Based on 2000 Census data, there were 15 block groups within the 50-mile radius of DAEC that exceeded the State average for low income households by 20 percent or more, or that were more than 50 percent low-income. The majority of census block groups with low-income populations were located in Black Hawk County. The nearest high density low-income population to DAEC is located in Cedar Rapids, Iowa. Based on 2000 Census data, Figure 4-2 shows low-income block groups within a 50-mile radius of DAEC.

Based on the analysis of impacts for other resource areas, the construction and operation of a coal-fired power plant alternative at the DAEC site may have adverse impacts on minority and low-income populations. However, minority and low-income populations in the area are relatively small and only a small number of workers are needed to construct and operate a natural gas-fired power plant and wind farm; impacts on these communities would not be disproportionate with that of the rest of the population within the 50-mile radius. Therefore, because there are no high or adverse impacts, by definition, there is also no disproportionate impact upon low income or minority populations.

8.1.7 Waste Management

Coal combustion generates several waste streams including ash (a dry solid) and sludge (a semi-solid byproduct of emission control system operation). The Staff estimates that 610 MW power plant would generate annually a total of 126,800 tons (115,000 MT) of dry solid ash and scrubber sludge. About 90,000 tons (81,600 MT) of this waste would be recycled. Disposal of the remaining waste from the 40-year operation of this alternative would require approximately 44 acres (18 ha). Disposal of the remaining waste could noticeably affect land use and groundwater quality, but would require proper citing in accordance with the Title 567, Chapter 101 "Solid Waste Comprehensive Planning Requirements" of the Iowa Administrative Code and the implementation of the required monitoring and management practices in order to minimize these impacts (IDNR, 2009). After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (EPA, 2000a) stating that it would issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act. The EPA has not yet issued these regulations.

The impacts from waste generated during operation of this coal-fired alternative would be MODERATE; the impacts would be clearly visible, but would not destabilize any important resource.

The amount of the construction waste would be small compared to the amount of waste generated during operational stage and much of it could be recycled. Overall, the impacts from waste generated during construction stage would be SMALL.

Therefore, the Staff concludes that the overall impacts from construction and operation of this alternative would be MODERATE.

8.2 NATURAL GAS COMBINED-CYCLE GENERATION

In this section, the Staff evaluates the environmental impacts of a natural gas-fired combined-cycle generation plant at the DAEC site.

Natural gas fueled 22 percent of electric generation in the US in 2007 (the most recent year for which data are available); this accounted for the second greatest share of electrical power after coal (EIA, 2009b). Like coal-fired power plants, natural gas-fired plants may be affected by perceived or actual actions to limit GHG emissions; they produce markedly lower GHG emissions per unit of electrical output than coal-fired plants. Natural gas-fired power plants are feasible and provide commercially available options for providing electrical generating capacity beyond DAEC's current license expiration date.

Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. They derive the majority of their electrical output from a gas-turbine cycle, and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The first, gas turbine stage (similar to a large jet engine) burns natural gas that turns a driveshaft that powers an electric generator. The exhaust gas from the gas turbine is still hot enough, however, to boil water into steam. Ducts carry the hot exhaust to a heat recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; thermal efficiency can exceed 60 percent. Since the natural gas-fired alternative derives much of its power from a gas turbine cycle, and because it wastes less heat than either the coal-fired alternative or the existing DAEC, it requires significantly less cooling.

In order to replace the 610 MWe that DAEC currently supplies, the Staff selected a gas-fired alternative that uses two Siemens SCC6-5000F combined-cycle generating units. While any number of commercially available combined-cycle units could be installed in a variety of combinations to replace the power currently produced by DAEC, the SCC6-5000F is a highly efficient model that would help minimize environmental impacts. Other manufacturers, like General Electric, offer similarly high efficiency models. This gas-fired alternative produces a net 275 MWe per unit. Two units produce a total of 590 MWe, or nearly the same output as the existing DAEC.

The combined-cycle alternative operates at a heat rate of 5960 btu/kWh, or about 57 percent thermal efficiency (Siemens, 2007). Allowing for onsite power usage, including cooling towers and site lighting, the gross output of these units would be roughly 615 MWe. As noted above, this gas-fired alternative would require much less cooling water than DAEC because it operates at a higher thermal efficiency and because it requires much less water for steam cycle condenser cooling. This alternative would likely make use of the site's existing mechanical draft cooling towers, and may only require the use of one tower instead of the currently operating two.

In addition to the already existing mechanical draft cooling towers, other visible structures onsite include the turbine buildings and HRSGs (which may be enclosed in a single building), two exhaust stacks, an electrical switchyard, and, possibly, equipment associated with a natural gas pipeline, like a compressor station. While GEIS estimates indicate that this 590 MWe plant would require 68 acres (27 ha), FPL-DA indicated that a natural gas alternative of comparable size (610 MWe) would require only 24 acres (10 ha) (FPL-DA, 2008). The Staff believes FPL-DA's estimate to be sound and will refer to it for the analysis of this alternative.

This 590 MWe power plant would consume 26.5 billion cubic feet (ft^3) (752 million cubic meters [m^3]) of natural gas annually assuming an average heat content of 1,029 btu/ft^3 (EIA, 2009c). Natural gas would be extracted from the ground through wells, then treated to remove impurities (like hydrogen sulfide), and blended to meet pipeline gas standards, before being piped through the interstate pipeline system to the power plant site. This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for emissions controls.

Environmental impacts from the gas-fired alternative would be greatest during construction. Site crews would clear vegetation from the site, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including a 15-mile pipeline spur to serve the plant and electricity transmission infrastructure connecting the plant to existing transmission lines. Constructing the gas-fired alternative on the DAEC site would allow the gas-fired alternative to make use of the existing electric transmission system.

Table 8-2. Summary of Environmental Impacts of the Natural Gas Combined-Cycle Generation Alternative Compared to Continued Operation of Duane Arnold Energy Center

	Natural Gas Combined-Cycle Generation	Continued DAEC Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL to MODERATE
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to MODERATE
Waste Management	SMALL	SMALL

8.2.1 Air Quality

Linn County, Iowa is in the EPA Region 7. All counties in the State of Iowa are in attainment for all criteria pollutants, except Muscatine County, which is a maintenance county for SO_2. A new gas-fired generating plant developed at the DAEC site would qualify as a new major-emitting industrial facility and require a New Source Review (NSR)/Prevention of Significant Deterioration of Air Quality review under CAA requirements, adopted by Iowa Department of Natural Resources (IDNR) in Section 567 of the Iowa Administrative Code (IDNR, 2008). The natural gas-fired plant would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60 Subpart GG.

40 CFR Part 51, Subpart P contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area (40 CFR Part 51, Subpart P, §51.307). If a gas-fired alternative were located close to a mandatory Class I area, additional air pollution control requirements would potentially apply. There are no mandatory Class I Federal areas in the State of Iowa and the closest mandatory Class I Federal area is Mingo Wilderness Area, which is located 365 miles southeast of DAEC in Missouri.

The Staff projects the following emissions for a gas-fired alternative based on data published by the EIA, the EPA, and on performance characteristics for this alternative and its emissions controls:

- Sulfur oxides (SOx) – 46.40 tons (42.10 MT) per year
- Nitrogen oxides (NOx) – 148.77 tons (134.96 MT) per year
- Carbon monoxide (CO) – 30.93 tons (28.06 MT) per year
- Total suspended particles (TSP) – 25.93 tons (23.53 MT) per year
- Particulate matter (PM) PM_{10} – 25.93 tons (23.53 MT) per year
- Carbon dioxide (CO_2) – 1,581,300 tons (1,434,500 MT) per year

A new natural gas-fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NOx, which are the main precursors of acid rain and the major cause of reduced visibility. Title IV establishes maximum SO_2 and NOx emission rate from the existing plants and a system of the SO_2 emission allowances that can be used, sold or saved for future use by new plants.

8.2.1.1 Sulfur and Nitrogen Oxides

As stated above, the new natural gas-fired alternative would produce 46.40 tons (42.10 MT) per year of SOx and 148.77 tons (134.96 MT) per year of NOx based on the use of the dry low NOx combustion technology and use of the selective catalytic reduction (SCR) in order to significantly reduce NOx emissions.

The new plant would be subjected to the continuous monitoring requirements of SO_2, NO_x and CO_2 specified in 40 CFR Part 75. The Staff computed that the natural gas-fired plant would emit approximately 1.6 million tons (approximately 1.4 million MT) per year of unregulated CO_2 emissions. As of today, there is no required reporting of GHG emissions for plants in Iowa. In response to the Consolidated Appropriations Act of 2008, the EPA has proposed a rule that requires mandatory reporting of GHG emissions from large sources that would allow collection of accurate and comprehensive emissions data to inform future policy decisions (EPA, 2009c). The EPA proposes that suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHG emissions submit annual reports to the EPA. The gases covered by the proposed rule are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE).

8.2.1.2 Particulates

The new natural gas-fired alternative would produce 25.93 tons (23.53 MT) per year of TSP, all of which would be emitted as PM_{10}

8.2.1.3 Hazardous Air Pollutants

The EPA issued in December 2000 regulatory findings (EPA, 2000b) on emissions of hazardous air pollutants from electric utility steam-generating units, which identified that natural gas-fired plants emit hazardous air pollutants such as arsenic, formaldehyde and nickel and stated that

> . . . the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

8.2.1.4 Carbon Monoxide

Based on EPA emission factors (EPA, 1998), Staff estimates that the total CO emissions would be approximately 30.93 tons (28.06 MT) per year.

8.2.1.5 Construction Impacts

Activities associated with the construction of the new natural gas-fired plant at the DAEC site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Workers' vehicles and motorized construction equipment would generate temporary exhaust emissions. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The Staff concludes that the impact of vehicle exhaust emissions and fugitive dust from operation of earth-moving and material handling equipment would be SMALL.

The overall air-quality impacts of a new natural gas-fired plant located at the DAEC site would be SMALL to MODERATE.

8.2.2 Groundwater Use and Quality

The use of groundwater for a natural gas-fired combined-cycle plant would likely be limited to supply wells for drinking water and possibly filtered service water for system cleaning purposes. Total usage would likely be much less than DAEC because many fewer workers would be onsite, and because the gas-fired alternative would have fewer auxiliary systems requiring service water.

No effects on groundwater quality would be apparent except during the construction phase due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the natural gas-fired alternative would be SMALL.

8.2.3 Surface Water Use and Quality

Total withdrawals of surface water from the Cedar River would be much less for a gas-fired plant than the 11,200 gpm (0.85 cubic meters per second [m^3/s]) currently used on average by DAEC, as well as the amount needed for the coal-fired alternative. Similarly, consumptive losses would be reduced, especially if the gas-fired alternative only requires the use of one of the mechanical draft cooling towers instead of the current two. Consumptive losses from the current DAEC unit are less than 0.1 percent of the average annual flow of the Cedar River, and would become much smaller if this gas-fired alternative were to replace DAEC. As such, the NRC concludes the impact of surface water use would be SMALL.

A new gas-fired plant would be required to obtain a National Pollutant Discharge and Elimination System (NPDES) permit from the Iowa Department of Natural Resources (IDNR) for regulation of industrial wastewater, storm water, and other discharges. Assuming the plant operates within the limits of this permit, the impact from cooling tower blow down, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.2.4 Aquatic and Terrestrial Ecology

8.2.4.1 Aquatic Ecology

Aquatic ecology actually benefits from the onsite, gas-fired alternative, compared to the existing plant as the combined-cycle plant injects significantly less heat to the environment, thus requiring less water. The number of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be smaller than that associated with license renewal because water consumption and blow down to the Cedar River would be substantially lower. Some temporary impacts to aquatic organisms might occur due to any construction or effluent discharge to the river, but NRC assumes that the appropriate agencies would be monitoring and regulating such activities. Although the number of affected organisms would be substantially less than for license renewal, the NRC level of impact for license renewal is already small, and so NRC expects that the levels of impact for impingement, entrainment, and thermal effects of this alternative would likewise be SMALL.

8.2.4.2 Terrestrial Ecology

As indicated in previous sections, constructing the natural gas alternative would require 24 acres (10 ha) of land. These land disturbances form the basis for impacts to terrestrial ecology.

Impacts to terrestrial ecology would be minor because the selected site has been previously disturbed and is mostly used for agricultural activities. (Gas extraction and collection would also affect terrestrial ecology in offsite gas fields, although, much of this land is likely already disturbed by gas extraction, and the incremental effects of this alternative on gas field terrestrial ecology are difficult to gauge.)

Construction of the two natural gas-fired units could result in the loss of farmland, which could affect food supply and habitat of native wildlife. However, these effects are not expected to be significant. Operation of the cooling towers would produce a visible plume and cause some deposition of dissolved solids on surrounding vegetation (including some wetlands) and soil from cooling tower drift, however, the GEIS indicates that the impact of cooling towers on agricultural crops is of small significance, and most of the land surrounding the cooling towers is farmland. These effects would be no more severe than the current DAEC operating cooling towers and could even be less if the gas-fired alternative uses only one of the two mechanical draft towers.

Construction of the 15 mile gas pipeline (to the nearest assumed tie-in) could lead to a conversion of up to 136 acres (55 ha) of forested lands used by terrestrial wildlife to a mowed right-of-way (ROW) as well as the loss of cropland from agricultural production, which could impact wildlife that use the croplands as a food source. Pipeline construction may fragment surrounding habitat and may increase edge habitat, which may adversely impact forest interior dwelling species, including migratory songbirds, as well as any threatened and endangered species in the affected area. However, much of the area surrounding DAEC is in agricultural use and therefore has been previously disturbed, so it is unlikely that a significant amount of forested land would be affected. FPL-DA also indicated that the pipeline would be routed along existing, previously disturbed ROWs to minimize any impacts. Because of the relatively small potential for undisturbed land to be affected, impacts from construction of the pipeline are expected to be small.

Based on this information, impacts to terrestrial resources would be SMALL.

8.2.5 Human Health

Like the coal-fired alternative discussed above, a gas-fired plant would emit criteria air pollutants, but in smaller quantities (except NOx, which requires additional controls to reduce emissions). Human health effects of gas-fired generation are generally low, although in Table 8-2 of the GEIS (NRC, 1996), the Staff identified cancer and emphysema as potential health risks from gas-fired plants. NOx emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on this gas-fired alternative maintain NOx emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NOx in the region would not increase. Health risks to workers may also result from handling spent catalysts that may contain heavy metals.

Overall, human health risks to occupational workers and to members of the public from gas-fired power plant emissions sited at DAEC would be less than the risks described for coal-fired alternative and therefore, would likely be SMALL.

8.2.6 Socioeconomics

8.2.6.1 Land Use

As discussed in Section 8.1.6, the GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a two unit natural gas-fired combined-cycle power plant at the DAEC site.

Based on GEIS estimates, FPL-DA indicated that approximately 24 acres (10 ha) of land would be needed to support a natural gas-fired alternative to replace DAEC (FPL-DA, 2008). This amount of onsite land use would include other plant structures and associated infrastructure, and is unlikely to exceed 64 acres (26 ha), excluding land for natural gas wells and collection stations. Onsite land use impacts from construction would be SMALL.

In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 5,200 acres (2,100 ha) would be required for wells, collection stations, and a 15 mile pipeline to bring the gas to the plant. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside of the United States and be delivered as liquefied gas.

The elimination of uranium fuel for the DAEC could partially offset offsite land requirements. Scaling from GEIS estimates, the Staff estimated that approximately 610 acres (247 ha) would not be needed for mining and processing uranium during the operating life of the plant. Overall land use impacts from a gas-fired power plant would be SMALL to MODERATE.

8.2.6.2 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new natural gas-fired power plant could affect regional employment, income, and expenditures. Two types of job creation would result: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Staff evaluated workforce requirements for construction and operation of the natural gas-fired power plant alternative in order to measure their possible effect on current socioeconomic conditions.

The socioeconomic impacts from constructing and operating a gas-fired plant would have little noticeable effect. Compared to the coal-fired alternative, the small size of the construction and operations workforce would have little or no socioeconomic impact.

While the GEIS estimates a peak workforce of 700, FPL-DA projected a maximum construction workforce of 344 (FPL-DA, 2008). The Staff finds this estimate to be reasonable and will refer to it for this analysis. During construction, the communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on local economy and tax base would vary over time.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce may have to move to be closer to the construction site. Although the ER identifies the DAEC site as a primarily rural site, it is located near three metropolitan areas: Waterloo (34 mi), Iowa City (32 mi), and Cedar Rapids (5.7 mi). Therefore, these effects would likely be lessened because workers are likely to commute to the site from these areas instead of relocating closer to the construction site. Because of the site's proximity to these highly populated areas, the impact of construction on socioeconomic conditions would be SMALL.

Scaling down from GEIS estimates of an operational workforce of 88 employees, FPL-DA estimated a power plant operations workforce of approximately 19 (FPL-DA, 2008). The FPL-DA estimate appears reasonable and is consistent with trends toward lowering labor costs by reducing the size of power plant operations workforces. The small number of operations workers are unlikely to have a noticeable effect on socioeconomic conditions in the region. Socioeconomic impacts associated with the operation of a gas-fired power plant at the DAEC would be SMALL.

8.2.6.3 Transportation

Transportation impacts associated with construction and operation of a two unit gas-fired power plant would consist of commuting workers and truck deliveries of construction materials to the DAEC site. During construction, between 340 and 700 workers would be commuting to the site. In addition to commuting workers, trucks would transport construction materials and equipment to the worksite increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Some plant components are likely to be delivered by train via the existing onsite rail spur. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact.

During plant operations, transportation impacts would almost disappear. According to FPL-DA, approximately 19 workers would be needed to operate the gas-fired power plant. Because fuel for the plant is transported by pipeline, a new gas-fired plant would have to be supported by the current gas pipeline system. If the required capacity is not available, any upgrades to the current pipeline system could have additional transportation impacts on the Midwest region.

The transportation infrastructure would experience little to no increased use from plant operations. Overall, the gas-fired alternative would have a SMALL impact on transportation conditions in the region around the DAEC.

8.2.6.4 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the natural gas-fired alternative and the surrounding landscape and the visibility of the gas-fired plant.

The two gas-fired units would be approximately 100 foot (30 m) tall, with an exhaust stack up to 500 feet (152 m) and may be visible offsite in daylight hours. However, the gas-fired plant would be shorter than the current DAEC reactor building, which stands at 140 feet (43 m) with a 328–foot (100-m) offgas stack. The mechanical draft towers would generate a condensate plume, but this would be no more noticeable than the existing DAEC plume. Depending on need, the coal-fired alternative may only require the use of one cooling tower instead of the current two, thus minimizing the size of the condensate plume. Noise and light from plant operations, as well as lighting on plant structures, may be detectable offsite. Pipelines delivering natural gas fuel could be audible offsite near gas compressors.

In general, aesthetic changes would be limited to the immediate vicinity of the DAEC and would likely be less than the currently operating DAEC plant. Impacts would likely be SMALL.

8.2.6.5 Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any proposed areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities. Site specific studies and surveys would be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). Areas with the greatest sensitivity should be avoided.

The impact for a gas-fired alternative at the DAEC site would be MODERATE. As noted in Section 4.9.6, potential impacts to historic and archaeological resources could be minimized or avoided if DAEC develops procedures and a cultural resource management plan that effectively consider historic and archaeological resources. This plan would ensure that informed decisions are made prior to any ground disturbing activities onsite. Plant procedures would also include an inadvertent discovery (stop work) provision. Depending on the resource richness of area ultimately chosen for the natural gas-fired alternative, impacts could be MODERATE.

8.2.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to subsection on Environmental Justice in Section 8.1.6.

Based on the analysis of impacts for other resource areas, the construction and operation of a gas-fired alternative at the DAEC site may have adverse impacts on minority and low-income populations. However, minority and low-income populations in the area are relatively small and only a small number of workers are needed to construct and operate a natural gas-fired power plant and wind farm; impacts on these communities would not be disproportionate with that of the rest of the population within the 50-mile radius. Therefore, because there are no high or adverse impacts, by definition, there is also no disproportionate impact upon low income or minority populations.

8.2.7 Waste Management

During the construction phase of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite or shipped to an offsite waste disposal facility. Because the alternative would be constructed on the previously disturbed DAEC site, the amounts of wastes produced during land clearing would be reduced.

During the operational stage, spent SCR catalysts used to control NOx emissions from the natural gas-fired plants, would make up the majority of the waste generated by this alternative. This waste would be disposed of according to applicable Federal and state regulations.

The Staff concluded in the GEIS (NRC, 1996), that a natural gas-fired plant would generate minimal waste and the waste impacts would be SMALL for a natural gas-fired alternative located at the DAEC site.

8.3 COMBINATION ALTERNATIVE

Consistent with a comment received from the public recommending that a wind-based energy alternative be investigated, the Staff has evaluated the environmental impacts of a combination of alternatives in this section. This combination would include a portion of the combined-cycle gas-fired capacity identified in 8.2, a conservation capacity component, and a wind power component. This alternative would require construction of a single gas-fired unit installed at the DAEC site and the construction of roughly 147 wind turbines (294-MWe nameplate capacity) at an offsite, or several different offsite locations.

In this alternative, a portion of DAEC's output—100 MWe—would be replaced by conservation. Inclusion of this conservation component of the alternative is based on Iowa's energy efficiency goals for the year 2013 (EPA, 2009b). Wind turbines constructed offsite would account for roughly 100 MWe of capacity (the 294 MWe of installed capacity would likely function at an average capacity factor of slightly greater than 30 percent, based on IDNR estimates) and 400 MWe would come from one GE S107H combined cycle power plant (IDNR, 2003).

The only major construction the Staff anticipates would happen at the current DAEC site where the combined-cycle gas-fired power plant would be erected; Additionally, wind turbines would be constructed at an offsite location. No construction is necessary for the conservation portion.

The appearance of the gas-fired facility would be similar to that of the full gas-fired alternative considered in 8.2, though a slightly larger, single unit would be constructed. The Staff estimates that this unit would require about 65 percent of the space necessary for the alternative considered in 8.2, and that all construction effects—as well as operational aesthetic, fuel-cycle, air quality, socioeconomic, land use, environmental justice, and water consumption effects—will scale accordingly.

Table 8-3. Summary of Environmental Impacts of the Combination Alternative Compared to Continued Operation of Duane Arnold Energy Center

	Combination Alternative	Continued DAEC Operation
Air Quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL to MODERATE
Aquatic and Terrestrial Resources	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL to MODERATE
Waste Management	SMALL	SMALL

8.3.1 Air Quality

Linn County, Iowa, where DAEC is located, is in EPA Region 7. All counties in the State of Iowa are in attainment for all criteria pollutants, except Muscatine County, which is a maintenance county for SO_2. Iowa Department of Natural Resources (IDNR) is responsible for managing and monitoring air quality in the State of Iowa.

This alternative is a combination of one 400-MW natural gas-fired combined-cycle generating unit, constructed onsite, 100 MW equivalent of conservation/demand-side management, and 294 MW of wind capacity constructed offsite, possibly at several different locations. The alternative would be similar in air quality impacts to the gas-fired alternative considered in 8.2, but would emit lower levels of pollutants. The wind power and conservation portions would have little to no effect on air quality during operations, though construction of wind power installations and infrastructure may have short-term effects on air quality when site preparation or other construction activities generate fugitive dust. The wind option would also result in a net offset in air pollutant emissions that would otherwise be generated by the fossil-fuel alternative to compensate for the 294 MW of wind generated capacity.

A new gas-fired generating plant on the DAEC site would qualify as a new major-emitting industrial facility and require a New Source Review (NSR) under Clean Air Act (CAA) and Section 567 of Iowa Administrative Code. The NSR program requires that a permit must be obtained before construction of the new major-emitting industrial facility (42 U.S.C. §7475(a)). The permit would be issued only if the new plant includes pollution control measures that reflect the best available control technology (BACT). The natural gas-fired unit would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60 Subpart GG.

40 CFR Part 51, Subpart P contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in attainment or unclassified areas and may affect visibility in any Federal Class I area (40 CFR Part 51, Subpart P, §51.307). If a gas-fired unit were located close to a mandatory Class I area, additional air pollution control requirements would apply. There are no mandatory Class I Federal areas in the State of Iowa and the closest mandatory Class I Federal area is Mingo Wilderness Area, which is located 365 miles southeast from the DAEC in Missouri.

The Staff projects the following emissions for the gas-fired portion of this alternative based on data published by the EIA, the EPA, and on performance characteristics for this alternative and its emissions controls:

- Sulfur oxides (SOx) – 31.33 tons (28.42 MT) per year
- Nitrogen oxides (NOx) (with SCR) – 100.44 tons (91.12 MT) per year
- Carbon monoxide (CO) – 20.88 tons (18.94 MT) per year
- Total suspended particles (TSP) – 17.51 tons (15.88 MT) per year
- Particulate matter (PM) PM_{10} – 17.51 tons (15.88 MT) per year
- Carbon dioxide (CO_2) – 1,099,000 tons (997,000 MT) per year

The natural gas-fired component of this alternative would produce 17.51 tons (15.88 MT) per year of TSP, all of which would be emitted as PM_{10}.

The EPA issued in December 2000 regulatory findings (EPA, 2000a) on emissions of hazardous air pollutants from electric utility steam-generating units, which identified that natural gas-fired plants emit hazardous air pollutants such as arsenic, formaldehyde and nickel and stated that

> . . . the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

The natural gas-fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NOx, which are the main precursors of acid rain and major causes of reduced visibility. Title IV establishes maximum SO_2 and NOx emission rate from the existing plants and a system of the SO_2 emission allowances that can be used, sold or saved for future use by the new plants.

As stated above, the new natural gas-fired unit would produce 31.33 tons (28.42 MT) per year of SOx and 100.44 tons (91.12 MT) per year of NOx based on the use of the dry low NOx combustion technology and the use of dry, low-NOx burners and SCR in order to significantly reduce NOx emissions.

The natural gas-fired component of this alternative would be subjected to the continuous monitoring requirements of SO_2, NOx and CO_2 specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 1.1 million tons (approximately 1.0 million MT) per year of unregulated CO_2 emissions. As of today, there is no required reporting of GHG emissions in Iowa. In response to the Consolidated Appropriations Act of 2008, the EPA has proposed a rule that requires mandatory reporting of GHG emissions from large sources, applicable to the presented alternative, in the United States that would allow collection of accurate and comprehensive emissions data to inform future policy decisions. The EPA proposes that suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHG emissions submit annual reports to the EPA (EPA, 2009c). The gases covered by the proposed rule are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). American Wind Energy Association data shows that Iowa takes second place in the nation with the greatest existing total wind power capacity. There would be no direct emissions from operating the wind component of the combination alternative.

Activities associated with the construction of the new natural gas-fired plant at the DAEC site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Workers' vehicles and motorized construction equipment would generate temporary exhaust emissions. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The Staff concludes that the impact of vehicle exhaust emissions and fugitive dust from operation of the earth-moving and material handling equipment would be SMALL.

The overall air-quality impacts of the combination alternative consisting of natural gas-fired plant located at DAEC site, energy conservation, and an offsite wind component would be SMALL.

8.3.2 Groundwater Use and Quality

If the onsite gas-fired plant continued to use groundwater for drinking water and service water, the total usage would likely be much less than DAEC uses, because many fewer workers are onsite, and because the gas-fired unit would have fewer auxiliary systems requiring service water. The current annual average withdrawal rate is 1,394 gpm, and pumping tests indicate this rate would not cause an effect on nearby supply wells. A reduction in this withdrawal rate means that impacts of the combination alternative would remain SMALL.

8.3.3 Surface Water Use and Quality

Using a combined alternative with conservation and wind power as major components would reduce the amount of surface water consumed for cooling purposes as compared to the proposed action and other alternatives considered in this section. The maximum consumptive use would be reduced from the amount of surface water consumed by the closed-cycle cooling system currently in use by DAEC. This represents less than 0.1 percent of the average annual flow rate in the Cedar River. The impact of this withdrawal would be SMALL.

8.3.4 Aquatic and Terrestrial Ecology

8.3.4.1 Aquatic Ecology

The wind and conservation components would have no associated impingement, entrainment, and thermal impacts. The number of fish and other aquatic resource organisms affected by impingement, entrainment, and thermal impacts would be less than those associated with license renewal because water consumption and blowdown returned to the Cedar River would be substantially lower when compared to the gas-fired component or any of the other alternatives considered in this section. Some temporary impacts to aquatic organisms might occur due to any construction that might occur in the river or cause effluent to the river, although NRC assumes that the appropriate agencies would be monitor and regulate such activities. Although the number of affected organisms would be substantially less than for license renewal, the NRC level of impact for license renewal is already small, and so NRC expects that the levels of impact for impingement, entrainment, and thermal effects would also be SMALL.

8.3.4.2 Terrestrial Ecology

The gas-fired component of this alternative would incorporate existing disturbed land and possibly some farmland at DAEC for the natural gas unit. This alternative would also require land offsite for the gas pipeline, and would require much additional land offsite to accommodate the number of turbines necessary in a wind farm to offset the power generated by DAEC.

This alternative would use the existing plant site land, switchyard, one of the two existing mechanical draft cooling towers, and transmission line system for construction of the gas-fired unit. Scaling from FPL-DA’s previous estimation of a slightly larger gas-fired plant, approximately 16 acres (6.6 ha) of land would be required on the DAEC site to support a 400 MWe natural gas plant.

Impacts to terrestrial ecology from onsite construction of this single gas-fired unit would be less than the impacts described for the two-unit gas-fired alternative. The impacts to farmland onsite would be approximately two-thirds of the impacts of the two-unit natural gas plant alternative. These onsite impacts are expected to be minor. Impacts to terrestrial ecology from offsite construction of the gas pipeline for a single gas-fired unit would be the same as for the two gas-fired unit alternative previously discussed (FPL-DA 2008).

Based upon data in the GEIS, the wind farm component of the combination alternative producing 294 MWe of electricity would require approximately 19,000 acres (7,600 ha) spread over several offsite locations, with approximately 74 acres (30 ha) in actual use. The remainder of the land would remain in agriculture. Additional land may be needed for construction of support infrastructure to connect to existing transmission lines.

Impacts to terrestrial ecology from construction of the wind farm portion of the combination alternative and any needed transmission lines could include loss of terrestrial habitat, an increase in habitat fragmentation and corresponding increase in edge habitat, and may impact threatened and endangered species. The GEIS notes that habitat fragmentation may lead to declines of migrant bird populations. Although bird mortality and disruptions to wildlife migratory routes could increase from construction of the wind farm, the GEIS notes that wind farms typically do not cause significant adverse impacts to bird populations (NRC, 1996).

Based on this information, impacts to terrestrial resources would be MODERATE.

8.3.5 Human Health

The human health risks from a combination of alternatives include the already discussed combined cycle gas-fired plant. The GEIS (NRC, 1996) notes that the environmental impacts of conservation/demand-side management alternative are likely to be centered on indoor air quality. This is due to increased weatherization of homes in the form of extra insulation and reduced air turnover rates from the reduction in air leaks. However, the actual impact from the conservation alternative is highly site specific and not yet well-established. For wind capacity, the GEIS notes that, except for a potential small number of occupational injuries, human health would not be affected by routine operations.

The human health risks from the combination of alternatives are uncertain, but considered to be SMALL given that the construction and operation of the facilities are expected to comply with health-based Federal and State safety and emission standards.

8.3.6 Socioeconomics

8.3.6.1 Land Use

The analysis of land use impacts for the combination alternative focuses on the amount of land area that would be affected by the construction and operation of a single natural gas-fired unit at the DAEC and an offsite wind energy generating facility, and demand-side energy conservation.

Land use impacts of an energy efficiency alternative would be SMALL. Quickly replacing and disposing of old equipment could generate waste material and potentially increase the size of landfills. However, given the time for program development and implementation, the cost of replacements, and the average life of equipment, the replacement process would probably be more gradual. Older equipment would likely be replaced by more efficient equipment as it fails (especially in the case of frequently replaced items, like light bulbs). In addition, many items (like home appliances or industrial equipment) have substantial recycling value and would likely not be disposed of in landfills.

Based on FPL-DA estimates, approximately 16 acres (6.5 ha) would be needed to support the single natural gas-fired unit portion of the combination alternative. Land use impacts from construction of the natural gas-fired power plant at DAEC would be SMALL.

In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Scaling from GEIS estimates, the natural gas-fired power plant at the DAEC could require 1,469 acres (594 ha) for wells, collection stations, and pipelines to bring the gas to the facility. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside of the United States and be delivered as liquefied gas.

The wind farm component of the combination alternative producing 294 MWe of electricity capacity would require approximately 19,000 acres (7,600 ha) spread over several locations with approximately 74 acres (30 ha) in actual use. Most likely, the land used to site these turbines would be agricultural cropland that would be largely unaffected by having the wind turbines onsite.

Although the offsite wind component of this alternative requires a large amount of land, only a small portion of that land would be in actual use. Also, the elimination of uranium fuel for the DAEC could partially offset offsite land requirements. Scaling from GEIS estimates, approximately 610 acres (247 ha) would not be needed for mining and processing uranium during the operating life of the plant. For these reasons, land use impacts from the combination alternative could range from SMALL to MODERATE.

8.3.6.2 Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new single natural gas-fired power plant at the DAEC and wind farm could affect regional employment, income, and expenditures. Two types of jobs would be created: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power generating operations, which have the greater potential for permanent, long-term socioeconomic impacts. The Staff conducted evaluations of construction and operations workforce requirements in order to measure their possible effect on current socioeconomic conditions.

Based on GEIS projections and a workforce of 1,200 for a 1,000-MWe plant, a single 400 MWe unit at DAEC would require a peak estimated construction workforce of 490 workers. Additional estimated construction workforce requirements for this combination alternative would include 300 construction workers for the wind farm. The number of additional workers would cause a short-term increase in the demand for services and temporary (rental) housing in the region around the construction site.

After construction, some local communities may be temporarily affected by the loss of the construction jobs and associated loss in demand for business services. The rental housing market could also experience increased vacancies and decreased prices. The impact of construction on socioeconomic conditions would be SMALL.

Following construction, a single unit gas-fired power plant at the DAEC could provide up to 13 jobs, based on FPL-DA estimates. Additional estimated operations workforce requirements for this combination alternative would include 50 operations workers for the wind farm. Given the small numbers of operations workers at these facilities, socioeconomic impacts associated with the operation of the natural gas-fired power plant at the DAEC and the wind farm would be SMALL.

Socioeconomic effects of an energy efficiency program would be SMALL. As noted in the GEIS, the program would likely employ additional workers. Lower-income families could benefit from weatherization and insulation programs. This effect would be greater than the effect for the general population because low-income households experience home energy burdens more than four times larger than the average household (OMB, 2007).

8.3.6.3 Transportation

Transportation impacts would be SMALL, because the number of employees commuting to the DAEC site, where the gas-fired portion is located, would be small. Any transportation effects from the energy efficiency alternative would be widely distributed across the State, and would not be noticeable or would only be temporarily noticeable when large wind turbine components are transported to the turbine sites.

Construction and operation of a natural gas-fired power plant and wind farm would increase the number of vehicles on roads in the vicinity of these facilities. During construction, cars and trucks would deliver workers, materials, and equipment to the worksites. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact. Highway delivery of large wind farm components may also cause impacts to traffic.

During plant operations, transportation impacts would almost disappear. Given the small numbers of operational workers at these facilities, levels of service impacts on local roads from the operation of the natural gas-fired power plant at the DAEC as well as the wind farm would be SMALL. Transportation impacts at the wind farm site or sites would also depend on current road capacities and average daily traffic volumes, but are likely to be small given the low number of workers employed by that component of the alternative.

8.3.6.4 Aesthetics

Aesthetic impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant.

A single natural gas-fired unit located at the DAEC could be approximately 100 feet (30 m) tall, with an exhaust stack up to 175 feet (53 m) tall. This is likely to be less noticeable than the current DAEC reactor building at 140 feet (42 m) with a 328-foot (100-m) offgas stack. The impact would be moderated as higher elevations and vegetation along the river valley could make it difficult to see or hear the power plant outside of the river valley. Power plant infrastructure would generally be smaller and less noticeable than the DAEC containment and turbine buildings. Noise during power plant operations would be limited to industrial processes and communications. In addition to the power plant structures, construction of natural gas pipelines would have a short-term impact. Noise from the pipelines could be audible offsite near compressors.

In general, aesthetic changes would be limited to the immediate vicinity of the DAEC and the wind farm facilities. The wind farm would have the greatest aesthetic effect. The 147 wind turbines at over 300 feet (100 m) tall and spread across multiple sites covering 19,000 acres (7,600 ha) may, in some locations, dominate the view and be a major focus of viewer attention. However, the overall impact would depend on the sensitivity of the site. Therefore, overall aesthetic impacts from the construction and operation of combination alternative would be SMALL to LARGE.

Impacts from energy efficiency programs would be SMALL. Some noise impacts could occur in instances of energy efficiency upgrades to major building systems, though this impact would be intermittent and short-lived.

8.3.6.5 Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The analysis of land use impacts for combination alternative focuses on the amount of land that would be affected by the construction and operation of a new natural gas-fired power plant at the DAEC site, an offsite wind farm, and a conservation energy component. The impact of constructing and operating a combination alternative at the DAEC site would be MODERATE, As noted in Section 4.9.6, potential impacts to historic and archaeological resources could be minimized or avoided if DAEC develops procedures and a cultural resource management plan that effectively consider historic and archaeological resources. This plan would ensure that informed decisions are made prior to any ground disturbing activities onsite. Plant procedures would also include an inadvertent discovery (stop work) provision. As discussed in Section 8.2.6, depending on the resource richness of the area selected for onsite development the impact would be MODERATE.

The wind farm component of the combination alternative would require approximately 19,000 ac (7,600 ha) spread over several locations with approximately 74 ac (30 ha) in actual use. Lands not previously surveyed should be investigated by a qualified archaeologist prior to any ground disturbing activity. Depending on the location of the wind farm, the visual impacts would also need to be assessed. The 147 wind turbines at over 300 ft (100 m) tall and spread across multiple sites covering 19,000 ac (7,600 ha) may, in some locations, dominate the view and could present historic viewshed impacts. Depending on the resource richness of the alternative site ultimately chosen for the wind power alternative, the impacts could range between SMALL to MODERATE.

Impacts to historic and archaeological resources from implementing the energy efficiency programs would be SMALL. A conservation alternative would not affect land use or historical or cultural resources onsite or elsewhere in the State.

8.3.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired power plant and wind farm. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to subsection on Environmental Justice in Section 8.1.6.

Weatherization programs could target low-income residents as a cost-effective energy efficiency option since low-income populations tend to spend a larger proportion of their incomes paying utility bills (according to the Office of Management and Budget, low income populations experience energy burdens more than four times as large as those of average households [OMB, 2007]). Impacts to minority and low-income populations from energy efficiency programs would be nominal, depending on program design and enrollment.

Based on the analysis of impacts for other resource areas, the construction and operation of the gas-fired component at the DAEC site and the offsite wind component may have adverse impacts on minority and low-income populations, somewhat depending on the location of the wind component. Minority and low-income populations in the area are relatively small and only a small number of workers are needed to construct and operate a natural gas-fired power plant and wind farm; impacts on these communities would not be disproportionate with that of the rest of the population within the 50-mile radius. Therefore, because there are no high or adverse impacts, by definition there is also no disproportionate impact upon low income or minority populations.

8.3.7 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite or shipped to the offsite waste disposal facility. During operational stage, spent SCR catalysts, which are used to control NOx emissions from the natural gas-fired plants, would make up the majority of the waste generated by this alternative.

There would be an increase in wastes generated during installation or implementation of conservation measures, such as appropriate disposal of old appliances, installation of control devices and building modifications. New and existing recycling programs would help to minimize the amount of generated waste.

The Staff concludes that overall waste impacts from the combination of the natural gas-fired unit constructed onsite, wind capacity, and conservation are SMALL.

8.4 ALTERNATIVES CONSIDERED BUT DISMISSED

In this section, the Staff presents the alternatives it initially considered for analysis as alternatives to license renewal of DAEC, but later dismissed due to technical, resource availability, or commercial limitations that currently exist and that the Staff believes are likely to continue to exist when the existing DAEC license expires. Under each of the following technology headings, the Staff indicates why it dismissed each alternative from further consideration.

8.4.1 Offsite Coal- and Gas-Fired Capacity

While it is possible that coal- and gas-fired alternatives like those considered in 8.1 and 8.2, respectively, could be constructed at sites other than DAEC, the Staff determined that they would likely result in greater impacts than alternatives constructed at the DAEC site. Greater impacts would occur from construction of support infrastructure, like transmission lines, roads, and railway spurs that are already present on the DAEC site. Further, the community around DAEC is already familiar with the appearance of a power facility and it is an established part of the region's aesthetic character. Workers skilled in power plant operations would also be available in this area. The availability of these factors are only likely to be available on other recently-industrial sites. In cases where recently-industrial sites exist, other remediation may also be necessary in order to ready the site for redevelopment. In short, an existing power plant site would present the best location for a new power facility.

8.4.2 Coal-Fired Integrated Gasification Combined-Cycle

While utilities across the United States have considered or are considering plans for integrated gasification combined-cycle (IGCC) coal-fired power plants, few IGCC facilities have yet been constructed. All facilities constructed in the United States to date have been smaller than DAEC, though Duke Energy's proposed Edwardsport IGCC would be similar in size (Duke Energy, 2008). The technology, however, is commercially available and essentially relies on a gasifier stage and a combined-cycle turbine stage. Existing combined-cycle gas turbines (like the ones considered in Section 8.2) could be used as a part of an IGCC alternative. Emissions would likely be slightly greater than those from the gas-fired alternative, but significantly lower than those from the coal-fired alternative. In addition, an IGCC alternative would require slightly less onsite space than the coal-fired alternative in 8.1 and operate at a higher thermal efficiency. Depending on gasification technology employed, it would likely use a similar quantity of water.

EIA indicates that IGCC and other advanced coal plants may become increasingly common in coming years, though uncertainties about construction time periods and commercial viability in the near future leads Staff to believe that IGCC is an unlikely alternative to DAEC license renewal (EIA, 2009a). For plants whose licenses expire at later dates, IGCC (with or without carbon capture and storage) may prove to be a viable alternative.

8.4.3 New Nuclear

In its ER, FPL-DA indicated that it is unlikely that a nuclear alternative could be sited, constructed and operational by the time DAEC operating license expires in February of 2014 (FPL-DA, 2008). Sources in the nuclear industry have recently indicated that reactor projects currently under development are likely eight or nine years from completion (Nucleonics Week, 2008), or possibly online in the 2016-2017 timeframe. A potential plant would also require additional time to develop an application. Given the relatively short time remaining on the current DAEC operating license, the Staff has not evaluated new nuclear generation as an alternative to license renewal.

8.4.4 Energy Conservation/Energy Efficiency

Though often used interchangeably, energy conservation and energy efficiency are different concepts. Energy efficiency typically means deriving a similar level of services by using less energy, while energy conservation simply indicates a reduction in energy consumption. Both fall into a larger category known as demand-side management (DSM). DSM measures—unlike the energy supply alternatives discussed in previous sections—address energy end uses. DSM can include measures that shift energy consumption to different times of the day to reduce peak loads, measures that can interrupt certain large customers during periods of high demand or measures than interrupt certain appliances during high demand periods, and measures like replacing older, less efficient appliances, lighting, or control systems. DSM also includes measures that utilities use to boost sales, such as encouraging customers to switch from gas to electricity for water heating.

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power generating source; it represents an option that states and utilities may use to reduce their need for power generation capability (NRC, 1996).

In February of 2008, a “green government” initiative was established in the State of Iowa, creating a task force tasked with the goal of reducing electricity use in office buildings by at least 15 percent by 2013. In addition, in May of 2008 S.F. 2386 was signed into effect by the governor which requires Iowa consumer-owned electric utilities to establish efficiency goals, setting an annual goal of a 1.5 percent improvement in demand-side energy efficiency (EPA, 2009d). On November 15, 2007, Iowa signed the Midwestern Regional Greenhouse Gas Reduction Accord, committing to an overall 2 percent reduction in energy use by 2015. If this goal was to be realized, however, conservation would still not be enough to replace the capacity of DAEC. Also, because these goals are considered optional (the utilities are only required to report back on their progress), it is unlikely that increased energy efficiency in the State of Iowa would have grown enough to offset the loss of DAEC by the license expiration in 2014. Because of this, the Staff has not evaluated energy conservation/efficiency as a discrete alternative to license renewal. It has, however, been considered as a component of the combination alternative.

8.4.5 Purchased Power

In its ER, FPL-DA indicated that purchased electrical power is not an economical alternative to DAEC license renewal. The Staff recognizes the potential for purchased power to offset a portion of the electricity generated by DAEC, however, for the 2014 to 2034 time frame of DAEC renewal, FPL-DA indicated that there are no guaranteed available power sources to replace the 610 MWe that DAEC provides (FPL-DA, 2008). Because of the lack of assured available purchased electrical power, the Staff has not evaluated purchased power as an alternative to license renewal.

8.4.6 Solar Power

Solar technologies use the sun's energy to produce electricity. Currently, the DAEC site receives approximately 3.5 to 4.5 kilowatt hour (kWh) per square meter per day, for solar collectors oriented at an angle equal to the installation's latitude (NREL, 2008). Since flat-plate photovoltaics tend to be roughly 25 percent efficient, a solar-powered alternative would require at least 23,000 acres (9,300 ha) of collectors to provide an amount of electricity equivalent to that generated by DAEC. Space between parcels and associated infrastructure increase this land requirement. This amount of land, while large, is consistent with the land required for coal and natural gas fuel cycles. In the GEIS, the Staff noted that, by its nature, solar power is intermittent (i.e., it does not work at night and cannot serve baseload when the sun is not shining), and the efficiency of collectors varies greatly with weather conditions. A solar-powered alternative would require energy storage or backup power supply to provide electric power at night. Given the challenges in meeting baseload requirements, the Staff did not evaluate solar power as an alternative to license renewal of DAEC.

8.4.7 Wood Waste

In 1999, DOE researchers estimated that Iowa has biomass fuel resources consisting of forest, mill, agricultural, and urban residues, as well as energy crop potential. Excluding potential energy crops, DOE researchers projected that Iowa had 24,490,500 tons (22,217,800 MT) of plant-based biomass available at $50 per ton delivered (Walsh et al., 2000; costs are in 1995 dollars). The Bioenergy Feedstock Development Program at Oak Ridge National Laboratory estimated that each air-dry pound of wood residue produces approximately 6,400 Btu of heat (ORNL, 2007). Assuming a 33 percent conversion efficiency, using all biomass available in Nebraska at $50 per ton—the maximum price the researchers considered—would generate roughly 30.3 terawatt hours of electricity.

Walsh et al. (2000), go on to note that these estimates of biomass capacity contain substantial uncertainty, and that potential availability does not mean biomass would actually be available at the prices indicated or that resources would be usably free of contamination. Some of these plant wastes already have reuse value, and would likely be more costly to deliver because of competition. Others, such as forest residues, may prove unsafe and unsustainable to harvest on a regular basis (the majority of biomass capacity in Iowa, however, comes from agricultural residues, with very little potential from forest residues). As a result, the available resource potential is likely less than the estimates totals in Walsh et al., and the total resource is not likely to be sufficient to substitute for the capacity provided by DAEC. As a result, the Staff has not considered a wood-fired alternative to DAEC license renewal.

8.4.8 Hydroelectric Power

According to researchers at Idaho National Energy and Environmental Laboratory, Iowa has an estimated 455 MW of technically available, undeveloped hydroelectric resources at 79 sites throughout the State (INEEL, 1997). Most of these sites have a potential capacity of less than 1 MWe, though the largest undeveloped site in Iowa is in the Iowa River Basin, which has 99 MW of potential. Given that the available hydroelectric potential in the State of Iowa constitutes less than the generating capacity of DAEC, the Staff did not evaluate hydropower as an alternative to license renewal.

8.4.9 Wave and Ocean Energy

Wave and ocean energy has generated considerable interest in recent years. Ocean waves, currents, and tides are often predictable and reliable. Ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. Most of these technologies are in relatively early stages of development, and while some results have been promising, they are not likely to be able to replace the capacity of DAEC by the time its license expires. Testing of new technologies to produce electricity from the ocean continues. However, because the DAEC site is not located near an ocean, the NRC did not consider wave and ocean energy as an alternative to DAEC license renewal.

8.4.10 Geothermal Power

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal electric generation is limited by the geographical availability of geothermal resources (NRC, 1996). Although Iowa has some geothermal potential in a heating capacity, it does not have geothermal electricity potential for electricity generation (DOE, 2007). The Staff concluded that geothermal energy is not a reasonable alternative to license renewal at DAEC.

8.4.11 Municipal Solid Waste

Municipal solid waste combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is currently the method used most frequently in the United States and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 89 waste-to-energy plants operate in the United States. These plants generate approximately 2,700 MWe, or an average of 30 MWe per plant (Integrated Waste Services Association, 2007). More than 27 average-sized plants would be necessary to provide the same level of output as the other alternatives to DAEC license renewal.

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired power plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC, 1996).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term as energy prices increase; however, it is possible that municipal waste combustion facilities may become attractive again.

Given the small average installed size of municipal solid waste plants and the unfavorable regulatory environment, the Staff does not consider municipal solid waste combustion to be a feasible alternative to DAEC license renewal.

8.4.12 Biofuels

In addition to wood and municipal solid waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. In the GEIS, the Staff indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as DAEC. After reevaluating current technologies, the Staff finds other biomass-fired alternatives are still unable to reliably replace the DAEC capacity. For this reason, the Staff does not consider other biomass-derived fuels to be feasible alternatives to DAEC license renewal.

8.4.13 Oil-Fired Power

EIA projects that oil-fired plants would account for very little of the new generation capacity constructed in the United States during the 2008 to 2030 time period. Further, EIA does not project that oil-fired power would account for any significant additions to capacity (EIA, 2009b).

The variable costs of oil-fired generation tend to be greater than those of the nuclear or coal-fired operations, and oil-fired generation tends to have greater environmental impacts than natural gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive (EIA, 2009b). The high cost of oil has prompted a steady decline in its use for electricity generation. Thus, the Staff did not consider oil-fired generation as an alternative to DAEC license renewal.

8.4.14 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air (or oxygen) over a cathode and separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

At the present time, fuel cells are not economically or technologically competitive with other alternatives for electricity generation. EIA projects that fuel cells may cost $5,374 per installed kW (total overnight costs) (EIA, 2009b), or 3.5 times the construction cost of new coal-fired capacity and 7.5 times the cost of new, advanced gas-fired, combined-cycle capacity. In addition, fuel cell units are likely to be small in size (the EIA reference plant is 10 MWe). While it may be possible to use a distributed array of fuel cells to provide an alternative to DAEC, it would be extremely costly to do so and would require many units. Accordingly, the Staff does not consider fuel cells to be an alternative to DAEC license renewal.

8.4.15 Delayed Retirement

FPL-DA indicated in the ER that it has no knowledge of any retired plants or any plans to retire plants in the State of Iowa prior to 2014 (FPL-DA, 2008). As a result, delayed retirement is not a feasible alternative to license renewal. Other generation capacity may be retired prior to the expiration of the DAEC license, but this capacity is likely to be older, less efficient, and without modern emissions controls.

8.5 NO-ACTION ALTERNATIVE

This section examines environmental effects that would occur if NRC takes no action. No action in this case means that NRC does not issue a renewed operating license for DAEC and the license expires at the end of the current license term, in February 2014. If NRC takes no action, the plant would shutdown at or before the end of the current license. After shutdown, plant operators would initiate decommissioning according to 10 CFR 50.82. Table 8-4 provides a summary of environmental impacts of No Action compared to continued operation of the DAEC.

The Staff notes that the option of no-action is the only alternative considered in-depth that does not satisfy the purpose and need for this SEIS, as it does not provide power generation capacity nor would it meet the needs currently met by DAEC or that the alternatives evaluated in sections 8.1 through 8.3 would satisfy. Assuming that a need currently exists for the power generated by DAEC, the no-action alternative would require that the appropriate energy planning decision-makers rely on an alternative to replace the capacity of DAEC or reduce the need for power.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities have already been addressed in several other documents, including the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC, 2002); the license renewal GEIS (chapter 7; NRC, 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever FPL-DA ceases operating DAEC.

The Staff notes that, even with a renewed operating license, DAEC would eventually shut down, and the environmental effects addressed in this section would occur at that time. Since these effects have not otherwise been addressed in this SEIS, the impacts will be addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license.

Table 8-4. Summary of Environmental Impacts of No Action Compared to Continued Operation of Duane Arnold Energy Center

	No Action	Continued DAEC Operation
Air Quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL to MODERATE
Aquatic and Terrestrial Resources	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to MODERATE
Waste Management	SMALL	SMALL

8.5.1 Air Quality

When the plant stops operating, there would be a reduction in emissions from activities related to plant operation such as use of diesel generators and employees vehicles. In Chapter 4, the Staff determined that these emissions would have a SMALL impact on air quality during the renewal term. Therefore, if the emissions decrease, the impact to air quality would also decrease and would be SMALL.

8.5.2 Groundwater Use and Quality

The use of groundwater would diminish as plant personnel are removed from the site and operations cease. Some consumption of groundwater may continue as a small staff remains onsite to maintain facilities prior to decommissioning. Overall impacts would be smaller than during operations, but would remain SMALL.

8.5.3 Surface Water Use and Quality

The rate of consumptive use of surface water would decrease as the plant is shut down and the reactor cooling system continues to remove the heat of decay. Wastewater discharges would also be reduced considerably. Shutdown would reduce the already SMALL impact on surface water resources and quality.

8.5.4 Aquatic and Terrestrial Resources

8.5.4.1 Aquatic Ecology

If the plant were to cease operating, impacts to aquatic ecology would decrease, as the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts to aquatic ecology.

8.5.4.2 Terrestrial Ecology

Terrestrial ecology impacts would be SMALL. No additional land disturbances on or offsite would occur.

8.5.5 Human Health

Human health risks would be smaller following plant shutdown. The plant, which is currently operating within regulatory limits, would emit less gaseous and liquid radioactive material to the environment. In addition, following shutdown, the variety of potential accidents at the plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Chapter 4 of this draft supplemental EIS, the Staff concluded that the impacts of continued plant operation on human health would be SMALL. In Chapter 5, the Staff concluded that the impacts of accidents during operation were SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and variety of accidents decrease following shutdown, the Staff concludes that the risks to human health following plant shutdown would be SMALL.

8.5.6 Socioeconomics

8.5.6.1 Land Use

Plant shutdown would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines connected to DAEC would remain in service after the plant stops operating. Maintenance of most existing transmission lines would continue as before. Impacts on land use from plant shutdown would be SMALL.

8.5.6.2 Socioeconomics

Plant shutdown would have an impact on socioeconomic conditions in the region around DAEC. Plant shutdown would eliminate approximately 669 jobs and would reduce tax revenue in the region. The loss of these contributions, which may not entirely cease until after decommissioning, would have a MODERATE impact. See Appendix J to NUREG-0586, Supplement 1 (NRC, 2002), for additional discussion of the potential socioeconomic impacts of plant decommissioning.

8.5.6.3 Transportation

Traffic volumes on the roads in the vicinity of DAEC would be reduced after plant shutdown. Most of the reduction in traffic volume would be associated with the loss of jobs at the plant. Deliveries of materials and equipment to the plant would be reduced until decommissioning. Transportation impacts would be SMALL as a result of plant shutdown.

8.5.6.4 Aesthetics

Plant structures and other facilities would remain in place until decommissioning. Noise caused by plant operation would cease. Aesthetic impacts of plant closure would be SMALL.

8.5.6.5 Historic and Archaeological Resources

Impacts from the no-action alternative would be SMALL, since DAEC would be decommissioned. A separate environmental review would be conducted for decommissioning. That assessment would address the protection of historic and archaeological resources.

8.5.6.6 Environmental Justice

Termination of power plant operations would not disproportionately affect minority and low-income populations outside of the immediate vicinity of DAEC. Impacts to all other resource areas would be SMALL to MODERATE. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to subsection on Environmental Justice in Section 8.1.6. Minority and low-income populations in the area are relatively small and only a small number of workers are needed to construct and operate a natural gas-fired power plant and wind farm; impacts on these communities would not be disproportionate with that of the rest of the population within the 50-mile radius. Therefore, because there are no high or adverse impacts, by definition, there is also no disproportionate impact upon low income or minority populations. See Appendix J of NUREG-0586, Supplement 1 (NRC, 2002), for additional discussion of these impacts.

8.5.7 Waste Management

If the no-action alternative were implemented the generation of high-level waste would stop and generation of low-level and mixed waste would decrease. Impacts from implementation of no-action alternative are expected to be SMALL.

8.6 ALTERNATIVES SUMMARY

In this chapter, the Staff considered the following alternatives to DAEC license renewal: supercritical coal-fired generation; natural gas combined-cycle generation; and a combination alternative. No action by the NRC and the effects it would have were also considered. The impacts for all alternatives are summarized in Table 8-5 on the following page.

Socioeconomic and groundwater impacts could range from SMALL to MODERATE. The Staff did not determine a single significance level for these impacts, but the Commission determined them to be Category 1 issues nonetheless. The environmental impacts of the proposed action (issuing a renewed DAEC operating license) would be SMALL for all other impact categories, except for the Category 1 issue of collective offsite radiological impacts from the fuel cycle, high level waste (HLW), and spent fuel disposal.

In the Staff's professional opinion, the coal-fired alternative would have the greatest over all adverse environmental impact. This alternative would result in MODERATE waste management, land use, and air quality impacts. Its impacts upon socioeconomic and biological resources could range from SMALL to MODERATE. This alternative is not an environmentally preferable alternative due to air quality impacts from nitrogen oxides, sulfur oxides, particulate matter, PAHs, carbon monoxide, carbon dioxide, and mercury (and the corresponding human health impacts), as well as construction impacts to aquatic, terrestrial, and potential historic and archaeological resources.

With the exception of land use, socioeconomic, and air quality impacts, the gas-fired alternative would result in SMALL impacts. Socioeconomic, land use, and air quality impacts could range from SMALL to MODERATE. This alternative would result in substantially lower air emissions, and waste management than the coal-fired alternative.

The combination alternative would have lower air emissions and waste management impacts than both the gas-fired and coal-fired alternatives, however it would have relatively higher construction impacts in terms of land use, aquatic and terrestrial resources, and potential disruption to historic and archaeological resources, mainly as a result of the wind turbine component.

Under the no-action alternative, plant shutdown would eliminate approximately 669 jobs and would reduce tax revenue in the region. The loss of these contributions, which may not entirely cease until after decommissioning, would have a SMALL to MODERATE impact. However, the no-action alternative does not meet the purpose and need stated in this draft SEIS.

Therefore, in the Staff's best professional opinion, the environmentally preferred alternative in this case is the license renewal of DAEC. All other alternatives capable of meeting the needs currently served by DAEC entail potentially greater impacts than the proposed action of license renewal of DAEC.

Table 8-5. Summary of Environmental Impacts of Proposed Action and Alternatives

Alternative	Impact Area						
	Air Quality	Groundwater	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socio-economics	Waste Management
License Renewal	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL[(a)]
Supercritical Coal-fired Alternative	MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	MODERATE
Gas-fired Alternative	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination Alternative	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL
No Action Alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

(a) For the DAEC license renewal alternative, waste management was evaluated in Chapter 6. Consistent with the findings in the GEIS, these impacts were determined to be SMALL with the exception of collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

8.7 REFERENCES

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9.0 CONCLUSION

This draft supplemental environmental impact statement (SEIS) contains the preliminary environmental review of FPL Energy Duane Arnold, LLC (FPL-DA) application for a renewed operating license for Duane Arnold Energy Center (DAEC) as required by Part 51 of Title 10, of the *Code of Federal Regulations* (10 CFR Part 51), which are the Nuclear Regulatory Commission's (NRC) regulations for implementing the National Environmental Policy Act (NEPA) of 1969. The following chapter:

- Provides a summary of environmental impacts of license renewal (Section 9.1)**;**

- Compares environmental impacts of license renewal and alternatives (Section 9.2);

- Addresses three basic requirements required under Section 102(C) of NEPA (Section 9.3); and

- Provides a preliminary NRC staff (Staff) recommendation regarding the License Renewal Alternative for DAEC (Section 9.4).

9.1 ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

License renewal impact issues have been previously reviewed and categorized in Chapter 4. Generic issues (Category 1) rely on the analysis provided in the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS) prepared by the U.S. Nuclear Regulatory Commission (NRC) and are discussed briefly in this SEIS (NRC 1996; 1999a). The Staff has also analyzed site-specific issues (Category 2) for DAEC. As explained in Chapter 1, impacts can be assigned a significance level of: SMALL, MODERATE, or LARGE.

The Staff has reviewed the site-specific Category 2 issues in this draft supplemental EIS. As applicable, mitigation measures were considered for Category 2 issues. In conducting this review, the Staff has conclude that with only two exceptions (water use conflicts, and historic and archaeological resources), issuing a license renewal would result in a SMALL impact to the issues reviewed in this SEIS. These two exceptions are described as follows.

> The first exception involves withdrawing surface water from the Cedar River, which could affect the underlying groundwater system. The Staff concluded that the impact to the groundwater system could range from SMALL to MODERATE. For both the Cedar River and underlying groundwater system, current practices for managing the impact of plant water usage were found to be adequate.
>
> The second exception involves potential impacts on historic and archaeological resources at DAEC, which could result in a MODERATE impact. Potential impacts could be minimized or avoided altogether, if DAEC develops procedures that more effectively consider historic and archaeological resources and develops a cultural resource management plan.

9.1.1 Other Environmental Impacts

No impacts beyond those discussed in the GEIS were identified for the issue of land use. The GEIS concluded that the impacts on land use are SMALL, and that additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted.

No impacts beyond those discussed in the GEIS were identified for the issue of air quality. The GEIS concluded that the impacts on air quality are SMALL, and that additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted.

No impacts beyond those discussed in the GEIS were identified for any aquatic or terrestrial resources. Consistent with the GEIS, the Staff therefore concludes that the impacts to aquatic and terrestrial resources, including threatened and endangered species are SMALL, and additional site-specific mitigation measures are unlikely to be sufficiently beneficial to warrant implementation.

No impacts beyond those discussed in the GEIS were identified for any health-related issues. The GEIS concluded that health-related impacts are SMALL, and that additional site-specific mitigation measures are unlikely to be sufficiently beneficial to be warranted.

With the exception of historic and archaeological resources (described above), the socioeconomic impacts (environmental justice considerations were not assigned a significance level) were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

No waste management impacts beyond those discussed in the GEIS were identified. Consistent with the GEIS, the Staff therefore concludes that the waste management impacts are SMALL, and additional site-specific mitigation measures are unlikely to be sufficiently beneficial to warrant implementation.

9.2 COMPARISON OF IMPACTS OF LICENSE RENEWAL AND ALTERNATIVES

The term “energy alternatives” is used to designate the: supercritical coal-fired alternative, natural gas combined-cycle alternative, and the combination alternative. This section compares environmental impacts of license renewal with the reasonable energy alternatives, including the alternative of taking no-action, which are described in Chapter 8.

As noted earlier, the alternative of license renewal could result in a water conflict usage impact of SMALL to MODERATE, and a MODERATE impact to historical or archaeological resources. On balance, these impacts are considered to be smaller than the environmental degradation of terrestrial and aquatic resources, air quality including the release of greenhouse gas (GHG) emissions, and socioeconomic disruptions as a result of constructing and operating one of the energy alternatives.

In the Staff’s best professional assessment, the impacts of license renewal are, on balance, less than or substantially less than those of the supercritical coal-fired alternative, particularly with respect to the issues of criteria pollutants, hazardous air pollutants (HAPs), GHG emissions, generation of waste products, and the potential for disrupting socioeconomic and biological resources.

With respect to the gas-fired alternative, the option of license renewal is, on balance, deemed to be moderately better, particularly with respect to deferring air and GHG emissions that would be produced if the gas-fired alternative were pursued, as well as potential socioeconomic disruptions.

When compared with the combination alternative, the option of license renewal is, on balance, deemed to be marginally better, particularly with respect to aquatic and terrestrial resources, and potential socioeconomic disruptions.

The only alternative that fairs better than the license renewal alternative is that of taking no-action. However, in terms of loss jobs and tax revenue, the no-action alternative would result in a larger socioeconomic impact than license renewal.

In summary, the Staff concludes that the impacts of license renewal are reasonable, and that on balance, the potential effects are generally less than those of pursuing the energy alternatives. Only the no-action alternative would result in equivalent or less impact than the alternative of license renewal; however, the no-action alternative does not meet the purpose and need for taking action.

9.3 SPECIAL CONSIDERATIONS PURSUANT TO SECTION 102(C) OF NEPA

Environmental impact of the license renewal are described in Chapters 4 and 6 of this SEIS, while impacts of alternatives are described in Chapter 8. In addition to investigating environmental impacts and alternatives to a proposed action, Section 102(C) of the NEPA statute also requires that an EIS specifically address:

- any adverse environmental effects which cannot be avoided should the proposal be implemented,

- the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

- any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

These requirements are described in the following sections.

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are those effects that would occur after implementation of all feasible mitigation measures. Implementing license renewal alternative or any one of the energy alternatives considered in this supplemental EIS would result in some unavoidable adverse environmental impacts. With the exception of water use conflicts and potential disruption to historical and archaeological resources, these unavoidable impacts would be SMALL.

Under the license renewal alternative, the existing plant and transmission corridors would continue to be used for their current mission. This alternative would continue to limit other land use options. However, no additional land would be required to support this alternative.

The alternative of license renewal would result in relatively minor unavoidable adverse impact on air quality as a result of equipment such as diesel generators and vehicles. Workers would be exposed to small amounts of hazardous nonradiological chemicals and waste, and the public would be exposed to small levels of chemical emissions. Many of these chemicals are also routinely used at other industrial and power plants, which are similar in size to DAEC. Use of chemicals would comply with applicable Federal and state regulations and emissions standards.

As described earlier, withdrawing surface water from the Cedar River could adversely affect the underlying groundwater system, which could be limit water use for other purposes. This impact could range from SMALL to MODERATE in scale. For both the Cedar River and underlying groundwater system, current practices for managing the impact of plant water usage are considered to be adequate.

Under the alternative of license renewal, the existing plant and transmission corridors would continue to be used for their current mission. This land would continue to pose a SMALL impact on biological resources. However, no additional biological disturbances would occur under this alternative.

Workers and members of the public would face exposure to small amounts of radioactive emissions. Workers would be exposed to radiation during routine plant operations, including routine nuclear fuel operations. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would comply with all applicable regulatory standards and administrative control limits. Chemical and radiological emissions would not exceed the National Emission Standards for criteria pollutants or hazardous air pollutants (HAPs). In comparison, alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the general public.

Potential disturbance to historic and archaeological artifacts could result in a MODERATE impact to these resources. Potential impacts could be minimized or avoided altogether, if FPL-DA implements procedures that more effectively consider historic and archaeological resources and develops a cultural resource management plan.

Workers would also face unavoidable exposure to small amounts of radiation from radioactive spent nuclear fuel and waste operations. Radiation levels that workers are exposed to are closely monitored. Exposures would not exceed applicable federal regulatory standards. All personal operations are also conducted in strict compliance with applicable federal regulations. Wastes streams generated during plant operation would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to conduct all activities and optimize all operations in a way that generates the smallest amount of waste practical. Management and disposal of this waste would require long-term funding and monitoring, and would consume space at treatment, storage, or disposal facilities to prevent release to the biosphere.

9.3.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

As used in this section, the term “short term” refers to the period of time during which DAEC power generating activities would continue. The principle short-term benefit derived from the alternative of license renewal would be generation of a relatively clean (the impacts of radiological waste are described below) and an economical supply of energy.

As described in Chapters 4 and 6, continued operation of the DAEC over the license renewal term would result in a number of short-term uses and impacts upon environmental resources. Operation of DAEC would continue to consume diesel and gasoline to power equipment and vehicles, electricity to power equipment. The plant site and the utility corridors would also result in a continued short-term impact to surrounding biological habitat and resources, and would limit land use options. After decommissioning the plant, the land might be released for other long-term productive uses, which could include re-establishment of biological habitat. Once the plant was shut down, water currently used for cooling purposes could be diverted to other long-term uses.

Water use could result in a long-term decrease in groundwater productivity. However, once the plant was shutdown and withdraw of water from the Cedar River ceased, the groundwater aquifer could be recharged.

DAEC air emissions would, over the short-term, introduce small amounts of hazardous and radioactive constituents into the biosphere. However, the exposure to hazardous and radioactive constituents is low, and it is unlikely that public health and long-term productivity of the environment would be significantly jeopardized. In comparison, the energy alternatives, particularly the Supercritical Coal-Fired Alternative, would result in emissions of criteria pollutants or hazardous air pollutants with potentially more serious health concerns to humans and biota.

In comparison, construction of any of the energy alternatives described in Chapter 8 would result in a long-term or permanent consumption of sizeable quantities of materials and resources such as steel, concrete, diesel and gasoline fuels, electricity, water, land, and potentially loss of biological habitat. In addition to construction resource usage, the energy alternatives would also consume fuel and other operational resources. With the possible exception of the Combination Alternative, the construction and operational resource impacts resulting from pursuing one of the energy alternatives would generally be greater than that consumed in operating the DAEC over a comparable timeframe; the combination alternative could result in long-term or permanent changes to land use, biological resources, and socio-economic disruptions.

Conclusion

Continued operation of the DAEC would produce spent nuclear fuel, and low-level radioactive waste, as well as hazardous and nonhazardous waste, which could have a long-term detrimental impact on biosphere and environmental productivity. Management and disposal of this waste would require long-term funding and monitoring, and would consume space at treatment, storage, or disposal facilities. Regardless of the location, geological containment and use of land to meet waste disposal needs would reduce the long-term productivity of the land and geological resources. In contrast, Supercritical Coal-Fired Alternative, and to a less extent the natural-gas alternative could produce sizeable quantities of hazardous waste with associated long-term impacts on environmental productivity.

Continued employment and employee expenditures, as well as tax revenues generated during a license renewal term would directly benefit local, regional, and state economies over the short term. Local agencies investing project-generated tax revenues into infrastructure and other public services could enhance socioeconomic productivity over a longer-term.

When compared with the no-action alternative, the short-term benefit of license renewal and the energy alternatives would be production of electricity. Conversely, there would be no short-term electrical generation benefit derived from pursuing the no-action alternative.

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources described in this SEIS. An irreversible commitment of a resource refers to primary or secondary impacts which limit future options for a resource. An irretrievable commitment of resources refers to the use or consumption of a resource that is neither renewable nor recoverable for future use. With respect to license renewal, irreversible actions include the short-term commitment of land for the plant and corridors, which would limit other land use options. Also related to this issue are the irreversible loss of biological habitat and species, at least until the plant is decommissioned and the land is released.

The license renewal alternative would result in an irretrievable commitment of cooling water which is diverted from other potential uses, including support of natural and biological resources. While surface water consumption represents a short-term loss of a renewable resource, lack of adequate groundwater recharge could constitute a longer-term irretrievable loss to the underlying aquifer.

An irretrievable commitment of material resources includes materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste.

One of the principle irreversible impacts is the generation of radioactive, and to a lesser extent, hazardous waste. The treatment, storage, and disposal of spent nuclear fuel, LLW, hazardous waste, and nonhazardous waste would require the long-term or permanent irretrievable commitment of land, as well as capital and personnel to manage and monitor the waste at storage, treatment, and disposal facilities. As an irreversible action, such waste might also have the potential to adversely affect the biosphere and other natural resources. In general, the commitment of capital and labor to provide long-term monitoring of this waste is an irretrievable commitment of socioeconomic resources.

In comparison, one of the principle irreversible impacts of a fossil-fuel alternative involves release of hazardous air constituents into the biosphere which can have long-term adverse effects on human health and biological resources. Unlike the alternative of license renewal, a fossil-fuel plant would also release substantial amounts of CO_2 and other GHGs. These GHGs might result in an irretrievable loss of ecological and natural resources.

The irreversible and irretrievable commitment of resources involved in constructing and operating any of the energy alternatives would be generally similar to, albeit, probably larger than those cited for the license renewal alternative. With respect to the energy alternatives, consumption of fossil fuels would be one of the irretrievable resource of principle concern. For the alternative of license renewal, the principle irretrievable resource commitment would be consumption of uranium-235.

The energy alternatives would also have the potential to result in an irretrievable loss of biological resources, water resources, and could adversely disrupt socioeconomic resources including historical and archaeological resources.

9.4 RECOMMENDATIONS

Based on (1) the analysis and findings in the GEIS, (2) information provided in the environmental report (ER) submitted by FPL Energy (3) consultation with Federal, State, and local agencies, (4) a review of pertinent documents and reports, and (5) consideration of public comments received during scoping, the preliminary recommendation of the Staff is that the NRC Commission determine that the adverse environmental impacts of license renewal for DAEC are not so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable

9.5 REFERENCES

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

The National Environmental Policy Act of 1969. Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982.

NRC (U.S. Nuclear Regulatory Commission). 1999a. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, “Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report.” NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 1999b. Environmental Standard Review Plan: Standard Review Plans for Environmental Reviews for Nuclear Power Plants. NUREG-1555, October 1999.

10.0 LIST OF PREPARERS

This supplemental environmental impact statement (SEIS) was prepared by members of the Office of Nuclear Reactor Regulation, with assistance from other NRC organizations and contract support from Argon National Laboratory.

Table 10-1. List of Preparers. *Argon National Laboratory provided contract support for preparing the SEIS.* Information Systems Laboratories *provided contract support in preparing the severe accident mitigation alternatives (SAMA) analysis, presented in Chapter 5 and Appendix F.*

Name	Affiliation	Function or Expertise
Nuclear Regulatory Commission		
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Jennifer Davis	Nuclear Reactor Regulation	Historic and Archaeological Resources
Ekaterina Lenning	Nuclear Reactor Regulation	Air Quality; Human Health
Jeffrey Rikhoff	Nuclear Reactor Regulation	Socioeconomics; Land Use; Environmental Justice
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Andrew Stuyvenburg	Nuclear Reactor Regulation	Alternatives (oversight)
Allison Travers	Nuclear Reactor Regulation	Alternatives
Briana Balsam	Nuclear Reactor Regulation	Aquatic/Terrestrial Ecology
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SAMA Contractor		
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Robert Schmidt	Information Systems Laboratories	Severe Accidents Mitigation Alternatives

(a) Argon National Laboratory, U.S. Department of Energy

11.0 INDEX

Appendix A

Comments Received on the Duane Arnold Energy Center Environmental Review

A. Comments Received On The Duane Arnold Energy Center, Environmental Review

A.1 Comments Received During Scoping

The Duane Arnold Energy Center (DAEC) scoping process began on March 24, 2009 with the publication of the U.S. Nuclear Regulatory Commission's (NRC) Notice of Intent to conduct scoping in the *Federal Register* (74 FR 12399). The scoping process included two public meetings held at Hiawatha City Hall, Iowa on April 22, 2009. Approximately 30 people attended the meetings. After the NRC's prepared statements pertaining to the license renewal process, the meetings were open for public comments. Oral statements were recorded and transcribed by a certified court reporter. Transcripts of the meeting, were attached to the Scoping Summary Report dated August 7, 2009 (NRC 2009). A total of two attendees registered to speak at the afternoon meeting session. When called upon, one of these registered speakers indicated that he had no comments. No one provided comments at the evening session. No other public scoping comments were received either through the mail or email.

The commenter was assigned a unique identifier. Table A-1 identifies the individual who registered to provide comments and the ID associated with the commenter's set of comments. To maintain consistency with the Scoping Summary Report, the unique identifier used in that report is retained in this appendix.

Specific comments were categorized and consolidated by topic. Comments can fall into one of the following general groups:

Specific comments that address environmental issues within the purview of the NRC environmental regulations related to license renewal. These comments address Category 1 (generic) or Category 2 (site-specific) issues or issues not addressed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS). They also address alternatives to license renewal and related Federal actions.

General comments (1) in support of or opposed to nuclear power or license renewal or (2) on the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to the TMI-1 license renewal application.

Comments that do not identify new information for the NRC to analyze as part of its environmental review.

Comments that address issues that do not to fall within or are specifically excluded from the purview of NRC environmental regulations related to license renewal. These comments typically address issues such as other accidents, emergency response and preparedness, security and terrorism, energy costs, energy needs, current operational safety issues, and safety issues related to operation during the renewal period.

Table A-1. Commenters on the Scope of the Environmental Review. *The comment is identified along with the affliliation and how their comment was submitted.*

Commenter ID	Commenter	Affiliation	Comment Source	ADAMS Accession Number
DAEC-1	Mr. Bennett Brown	Member of the public	Afternoon Scoping Meeting Session	ML091910273

Comments received during scoping applicable to this environmental review are presented in the following sections along with the NRC response. The comments that are general or outside the scope of the environmental review for DAEC are not included here, but can be found in the Scoping Summary Report (NRC 2009).

Scoping comments are grouped in the following categories:

- Alternatives
- Postulated Accidents

A.1.1 Alternatives

Comment DAEC-1: The Department of Natural Resources and the state of Iowa assessed the state's wind resource and concluded that the state of Iowa [is] developing only class 4 jacobs sites. These are currently developable at two and-a-half cents a kilowatt hour, would produce six times as much electricity as needed by the state of Iowa.

The Midwest Independent Systems Operators as well as other utility grid operators have studied how much wind penetration the grid could sustain given the variability of the wind and concluded that we could provide 15 to 25 percent of our electricity from wind without any alterations in the existing grid. So the percentage of electricity produced in the state of Iowa from Duane Arnold could easily be replaced by wind turbines with existing technology and existing market support.

Response: This comment is related to the environmental impacts of alternatives to license renewal of the DAEC. The impacts of a range of reasonable alternatives are presented in Chapter 8 of this supplemental environmental impact statement (SEIS). In response to this comment, the NRC staff has evaluated a “combination alternative.” The combination alternative includes a portion of the combined-cycle gas-fired capacity identified in Section 8.2, as well as a conservation capacity component, and a wind power component.

Comment: The second thing that I'd like to see that the SEIS addresses is the effect on employment decommissioning. As I see it, this is not a question of whether to extend the life of the plant by 20 years but rather a question as to whether to decommission it in 2014 or 2034. And so the question is when would we rather have the jobs provided necessary to decommission this plant and construct a renewable source, or at least some other source of electricity whether that's a new nuclear plant or a new coal plant or wind plants. And the Congress requires that the operators of this nuclear plant provide $359,000,000 in a trust fund by 2014.

That money spent beginning in 2014 to provide job decommissioning in this plant would be a boon to the local economy and the 2.4 billion, and there that's really a number off the top of my head there just saying, well, 800 megawatts times three per wind because of the name plate issue, I don't know how familiar you are with wind, but an 800 megawatt nuclear plant takes 2400 megawatts of wind to replace it. So that's roughly $2.4 billion in construction of wind turbines and the associated jobs that come with that construction on top of some 300 full time jobs maintaining that wind energy. That would be a significant boon to the state of Iowa and I would encourage the NRC to look at the economic impact on the state of replacing this nuclear plant with wind as distributed around the state.

Response: The environmental and socioeconomic impacts of decommissioning have been reviewed in Chapter 7 of the SEIS. Section 8.5 of the SEIS also examines environmental and socioeconomic effects that would occur if NRC takes no action to renew the DAEC operating license. In response to this comment, the NRC staff has also evaluated a “combination alternative.” This combination alternative includes a portion of the combined-cycle gas-fired capacity identified in Section 8.2 of the SEIS, as well as a conservation capacity component, and a wind power component. Section 8.3.6.2 of the SEIS discusses socioeconomic impacts, including those associated with employment and construction of a wind farm.

A.1.2 Safety and Postulated Accidents

Comment DAEC-1: The third point that I'd like to make has to do with the environmental impact of a severe accident. And I understand that you also have a safety review portion of the process and I also understand that the 9th Circuit Court has ruled that your SEIS must include an analysis of accidents in the jurisdiction of the 9th Circuit Court. So in lack of ruling from this Circuit Court, I believe that ruling has precedence and I would ask that you include accidents and the impacts of accidents in the SEIS --

Specifically on this point I would refer to the Sandia Lab Study commissioned by the NRC in 1982 which calculated the impacts of a severe accident with core damage estimating 3,000 peak fatalities immediately after the accident within a 25 mile radius, and 12,000 radiation injuries in the early aftermath of an accident within a 35 mile radius. And calculate the plant operators, calculate at any given time if all equipment is operating correctly, that the core damage frequency is one in 3,000,000 per reactor year. But sometimes parts are out of operation and the possibility that there's a severe accident under their calculations go up.

I would ask for this SEIS that the NRC address the likelihood of an accident taking into account more than the plant operators include in their calculation of the CDF, particularly their probabilistic risk assessment assumes that all parts operate as though they were new and have not been subjected to problems of radiation exposure, heat exposure, fluctuation of temperature, pressure exposure and embrittlement.

In this regard, I'd specifically point out that the CDF excludes vessel failure. This is a Mark 1 reactor. It's one of 18 Mark 1 reactors in the country. A study published by the Union of Concerned Scientists in 1995 looked at the vessel internals aging in the 18 Mark 1 reactors in the country as a result of discoveries of major fissures and cracks in Mark 1 core shrouds and found that at about 20 years of operation the exposure to radiation and heat fluctuation caused moderate or extensive cracking in seven out of the 18 Mark 1 reactors.

Duane Arnold at that time had no cracking evident and I would encourage the NRC to consider the possibility that a 40 year license that was initially granted to this reactor has allowed the investors to recoup their losses and that we are lucky today that the aging of the parts has not resulted in an accident. But a 20 year extension of the license represents too great a risk to this site specific plan for an accident.

If the core shroud detailed in the UCS report is one of just 21 vessel internal components subject not only to the cracking that is described in that report, but also to erosion, embrittlement, fatigue, creep, as well as stress corrosion cracking. So if these vessel internal parts were to prevent an insertion of the control rods, then the consequences of an accident could be quite severe.

In addition, the secondary containment which is meant to control the impact and mitigate the impact of such an accident in this particular reactor, was discovered to be faulty in the early days of operation of this reactor and the 17 other reactors like it in the country.

In fact, in 1986 Harold Denton, at that time a Chief Safety Officer with the NRC, in leading a meeting of Mark 1 operators declared that the taurus, as it is known, a million gallon tank of water to suppress heat in the event that the reactor was unable to be shut down and no where for the heat to go because of a loss of connectivity to the grid for instance, that there was a 90 percent probability that that taurus would fail at a meeting of Mark 1 operators.

And so as a result of that assessment, Mark 1 operators were instructed to install a bypass system that instead of trying to contain the pressure from the reactor using secondary containment, would simply bypass secondary containment and vent the taurus directly to the atmosphere through a butterfly valve operated in the control room. And Duane Arnold officials here today verify that, in fact, that is the situation at Duane Arnold, that it's not different than the other 17 Mark 1's.

And I think that I can understand why you would let a plant live out its 40 year operating license knowing that it had a design deficiency off by a factor of 10 in the size of the secondary containment in order to allow investors to recoup their investment. But to extend the plant's life for another 20 years when a viable alternative exists that would be a boon to the state's economy, I think is something that should be viewed with skepticism.

Finally, I think that the NRC should look at the history of scrams. Every scram at this reactor significantly ages the components. It subjects the components to significant changes in temperature, just like when you take a hot glass and submerge it suddenly in cold water. It can shatter parts inside a reactor every time you scram the reactor or suddenly subject it from one pressure extreme to another, from one temperature extreme to another and this significantly ages parts.

If the reactor, for instance, had in the non-radiation side, had a metal part break off at a filet weld simply because it had been cycled between hot and cold, and that metal part found its way through the system, scored open a number of tubes. Finally, the problem was turned up because water leaked first into one part and then overflowed into another part of the plant, and it was only once the plant was shut down and people investigated that they found tubes slashed open and eventually found the metal part that worked its way loose. That sort of risk is simply unnecessary and there's a viable alternative to the nuclear plant's continued operation.

The final point that I'd like to make concerning the reactor itself is this plant's specific risk to a terrorist attack. The plant is in proximity to the Rockwell Collins plant that used to be in the Soviet Union's top three list of targets because of its role in our nation's nuclear arsenal, missile guidance and intelligence. That means that both an attack on Rockwell Collins would have an impact on the plant, on its safety, on its ability to evacuate and so on.

It also means that there could be an indirect threat to the plant because a terrorist attack might find the plant a useful target in order to move military protection away from Rockwell Collins or the further strategic air command in Omaha in order to free up the vulnerability of SEC. So the specific location of this plant represents a hazard that needs to be looked at from the perspective of a terrorist attack.

And in addition, the Mark 1 design has a spent fuel pool that's on top of a building that is essentially unprotected, that various studies have concluded that a piece of weaponry that can be moved around in the trunk of a car and launched from somebody's shoulder, a howitzer, could penetrate that building and create a fire in the spent fuel pool. In addition, that spent fuel pool would be committed to use for five years beyond decommissioning because if we were to decommission the plant even today, then we would need to store the spent fuel for a minimum of five years on that local site.

So we're looking at a terrorist threat, a target, an attractive target for five years beyond decommission and I think it needs to be considered whether in this day and age it's really necessary to continue maintaining such an attractive target.

Response:

As part of the license renewal environmental review, the NRC staff evaluates the environmental impacts of postulated accidents. This evaluation is documented in Chapter 5 of this DSEIS. This comment raises concerns regarding several different aspects of consequences from such potential accidents.

First, with respect to a ruling from the Ninth Circuit Court of Appeals stating that the issue of terrorism must be considered in NEPA documents. The Commission respectfully disagreed with the Ninth Circuit's view, but stated that it will follow that ruling in the Ninth Circuit, indicating its belief that a different outcome might be reached by other Courts of Appeals (Oyster Creek, CLI-07-8, 65 NRC at 128). The DAEC is not located within the jurisdiction of the Ninth Circuit and therefore this DSEIS is not subject to the court’s finding. However, Section 5.2 of this DSEIS does provide a discussion regarding the GEIS’s consideration of severe accidents from phenomena such as sabotage, and its conclusion that the core damage and radiological release from such acts would be no worse that the damage and release expected from internally initiated events.

Further, in a recent case of *The State of New York v. NRC*, two states filed rulemaking petitions asking NRC to reverse its GEIS conclusion, which found that spent fuel pools located at nuclear reactors do not create a significant environmental impact--the GEIS classifies on-site storage of spent fuel in pools as a category I issues that causes a small impact. The risks posed by storing nuclear fuel in such pools, including the risk of fire, have been considered in various studies. Some of these studies (including those conducted since September 2001) have also considered the risk of fire precipitated by a terrorist attack and have classified that risk as low. In a ruling in favor of the NRC, the Second Circuit Court of Appeals concluded that NRC's decision denying rulemaking petitions was reasoned.[1]

Secondly, the commenter raised an issue concerning the "Sandia Lab Study" (Sandia Siting Study). The 1982 Sandia Siting Study (also referred to as the CRAC-II report) attempted to estimate source terms (i.e., magnitude, timing, and characteristics of the radioactive material released to the environment from a severe accident) for a severe nuclear reactor accident. A later study, NUREG-0773, concluded that the source terms used in Sandia Siting Study were based on "known deficiencies which would tend to give overestimates of the magnitude of the releases" (NRC 1982). Another study, NUREG-1150, used a probabilistic risk assessment to improve upon the Sandia Siting Study. The NUREG-1150 study confirmed that the Sandia Siting Study had produced invalid results because it looked at the effects of very unlikely severe accidents.

The 1996 GEIS used information from 28 plant-specific EISs, where the impacts from severe accidents were analyzed in their plant-specific EISs to project the environmental impact from all U.S. plants (see Table 5.5, GEIS 1996). As stated in Section 5.3.3.1 of the 1996 GEIS, the source terms used in assessing these severe accidents were generally based on those documented in the NUREG-0773 study (NRC 1982). Since completion of NUREG-0773 study, additional information on source terms has been developed through experimental and analytical programs. The comparison of the new source term information to that used in the 1996 GEIS impact projection shows that the amount of released radioactive material in a postulated severe accident to be less than that estimated in the 1996 GEIS. Thus, the environmental impacts used as the basis for the 1996 GEIS are even more conservative than an estimate using more recent source term information. In addition, a substantial effort is also ongoing to re-quantify realistic severe accident source terms under the state-of-the-art reactor consequence analysis (SOARCA) project. Preliminary results indicate that source terms, timing, and magnitude may be significantly later and lower than quantified in previous studies, including the 1996 GEIS.

Thirdly, the commenter asked that NRC address the likelihood of an accident, taking into account more than the current assumptions used for calculating CDF. Specifically, the commenter raised various concerns about systems and components including those identified in a 1995 Union of Concerned Scientists report. As stated above, with respect to the environment impacts associated with all postulated accidents, Chapter 5 of this DSEIS provides a discussion

[1] The State of New York v. NRC, United States Court of Appeals for the Second Circuit, Docket Nos. 08-3903-ag (L), 08-4833-ag (con), 08-5571-ag (con). Decided: December 21, 2009.

of the NRC staff's evaluation. With respect to the safety aspect of such systems and components being able to operate for another 20 years, the NRC staff makes that determination as part of its license renewal safety review, which focuses on the programs and processes that are designed to assure adequate protection of the public health and safety is maintained during the 20-year license renewal period through management of aging components. As part of the license renewal safety review, the applicant will be required to demonstrate that the effects of aging will be adequately managed.

Finally, the commenter also raised various concerns about systems and components that are related to the safe day-to-day operation of the plant, such as scram history and the secondary containment's ability to mitigate impacts of an accident involving a Mark 1 reactor. Although not within the scope of the license renewal review, which focuses on aging management, these issues are addressed as part of the NRC's ongoing oversight role, which includes, among other things, rigorous inspections, performance monitoring, and enforcement capability to ensure safe operation of commercial reactors.

A.2 References

74 FR 12399. U.S. Nuclear Regulatory Commission, Washington, D.C, "FPL Energy Duane Arnold, LLC; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register:* Vol. 74, No. 55, pp. 12399–12401. March 24, 2009.

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Sandia National Laboratory 1982. Sandia Siting Study (also referred to as the CRAC-II report), NUREG/CR-2239.

Appendix B

NEPA Issues for License Renewal of Nuclear Power Plants

B. NEPA Issues for License Renewal of Nuclear Power Plants

Table B-1. Summary of Issues and Findings. *This table is taken from Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51. Data supporting this table are contained in NUREG-1437,* Generic Environmental Impact Statement for License Renewal of Nuclear Plants. *Throughout this report, "Generic" issues are also referred to as Category 1 issues, and "Site-specific" issues are also referred to as Category 2 issues.*

Issue	Type of Issue	Finding
Surface Water Quality, Hydrology, and Use		
Impacts of refurbishment on surface water quality	Generic	SMALL. Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.
Impacts of refurbishment on surface water use	Generic	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures	Generic	SMALL. Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered salinity gradients	Generic	SMALL. Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	Generic	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water	Generic	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.
Eutrophication	Generic	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

Issue	Type of Issue	Finding
Discharge of chlorine or other biocides	Generic	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.
Discharge of sanitary wastes and minor chemical spills	Generic	SMALL. Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.
Discharge of other metals in wastewater	Generic	SMALL. These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	Site-specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
		Aquatic Ecology
Refurbishment	Generic	SMALL. During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.
Accumulation of contaminants in sediments or biota	Generic	SMALL. Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton	Generic	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cold shock	Generic	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling

Issue	Type of Issue	Finding
		systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	Generic	SMALL. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Distribution of aquatic organisms	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects	Generic	SMALL. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease)	Generic	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Low dissolved oxygen in the discharge	Generic	SMALL. Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms)	Generic	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or

Issue	Type of Issue	Finding
		cooling ponds and is not expected to be a problem during the license renewal term.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	Site-specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	Generic	SMALL. The impingement has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Heat shock	Generic	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Ground Water Use and Quality		
Impacts of refurbishment on ground water use	Generic	SMALL. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced

Issue	Type of Issue	Finding
and quality		during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.
Ground water use conflicts (potable and service water; plants that use <100 gpm)	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any ground water use conflicts.
Ground water use conflicts (potable and service water, and dewatering plants that use >100 gpm)	Site-specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause ground water use conflicts with nearby ground water users. See § 51.53(c)(3)(ii)(C).
Ground water use conflicts (plants using cooling towers withdrawing make-up water from a small river)	Site-specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Ground water use conflicts (Ranney wells)	Site-specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential ground water depression beyond the site boundary. Impacts of large ground water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Ground water quality degradation (Ranney wells)	Generic	SMALL. Ground water quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of ground water and is not expected to be a problem during the license renewal term.
Ground water quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion.
Ground water quality degradation	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade ground water quality. Because water in salt marshes is brackish, this is not a concern for plants

Issue	Type of Issue	Finding
(cooling ponds in salt marshes)		located in salt marshes.
Ground water quality degradation (cooling ponds at inland sites)	Site-specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade ground water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).
	Terrestrial Ecology	
Refurbishment impacts	Site-specific	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Bird collisions with cooling towers	Generic	SMALL. These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right of way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collisions with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of	Generic	SMALL. No significant impacts of electromagnetic fields

Issue	Type of Issue	Finding
electromagnetic fields on flora and fauna		on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Floodplains and wetland on power line right of way	Generic	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.
	Threatened and Endangered Species	
Threatened or endangered species	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).
	Air Quality	
Air quality during refurbishment (non-attainment and maintenance areas)	Site-specific	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See § 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
	Land Use	
Onsite land use	Generic	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.
Power line right of way	Generic	SMALL. Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.
	Human Health	

Issue	Type of Issue	Finding
Radiation exposures to the public during refurbishment	Generic	SMALL. During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures during refurbishment	Generic	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes including radiation is in the mid-range for industrial settings.
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.
Electromagnetic fields – acute effects (electric shock)	Site-specific	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields – chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.

Issue	Type of Issue	Finding
Occupational radiation exposures (license renewal term)	Generic	SMALL. Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.
	Socioeconomic Impacts	
Housing impacts	Site-specific	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).
Public services: public safety, social services, and tourism, and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services: education (refurbishment)	Site-specific	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See § 51.53(c)(3)(ii)(I).
Public services: education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected
Offsite land use (refurbishment)	Site-specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services:	Site-specific	SMALL, MODERATE, OR LARGE. Transportation

Issue	Type of Issue	Finding
transportation		impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment)	Generic	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Postulated Accidents		
Design basis accidents	Generic	SMALL. The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.
Severe accidents	Site-specific	SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management		
Offsite radiological impacts (individual effects	Generic	SMALL. Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid

Issue	Type of Issue	Finding
from other than the disposal of spent fuel and high level waste)		releases including radon-222 and technetium-99 are small.
Offsite radiological impacts (collective effects)	Generic	The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U. S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1 [Generic].
Offsite radiological	Generic	For the high level waste and spent fuel disposal component of the fuel cycle, there are no current

Issue	Type of Issue	Finding
impacts (spent fuel and high level waste disposal)		regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) 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 which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 3×10^{-3}. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would

Issue	Type of Issue	Finding
		involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR Part 191 protect the population by imposing amount of radioactive material released over 10,000 years. The cumulative release limits are based on EPA's population impact goal of 1,000 premature cancer deaths worldwide for a 100,000 metric ton (MTHM) repository. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered in Category 1 [Generic].
Nonradiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land

Issue	Type of Issue	Finding
		that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.
Mixed waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.
On-site spent fuel	Generic	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.
Nonradiological waste	Generic	SMALL. No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.
Transportation	Generic	SMALL. The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10

Issue	Type of Issue	Finding
		CFR 51.52(c), Summary Table S–4 – Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.
		Decommissioning
Radiation doses	Generic	SMALL. Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.
Waste management	Generic	SMALL. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	Generic	SMALL. Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.
Water quality	Generic	SMALL. The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.
		Environmental Justice
Environmental Justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-

Issue	Type of Issue	Finding
		specific reviews.

Appendix C

Applicable Regulations, Laws, and Agreements

C. Applicable Regulations, Laws, and Agreements

Table C-1 lists environmental authorizations for current Duane Arnold Energy Center (DAEC) operations. In this context “authorizations” includes any permits, licenses, approvals, or other entitlements. FPL Energy Duane Arnold, LLC (FPL-DA) expects to continue renewing these authorizations during the current license period and through the U.S. Nuclear Regulatory Commission (NRC) license renewal period.

Table C-2 lists additional environmental authorizations and consultations related to FPL-DA renewal of the DAEC license to operate. As indicated, FPL-DA anticipates needing relatively few such authorizations and consultations. Sections C.1 through C.5 discuss some of these items in more detail.

C.1 HISTORIC PRESERVATION

Under Section 106 of the National Historic Preservation Act (16 USC 470 et seq.), federal agencies having the authority to license any undertaking, prior to issuing the license, shall take into account the effect of the undertaking on historic properties and shall afford the Advisory Committee on Historic Preservation an opportunity to comment on the undertaking. Committee regulations provide for establishing an agreement with any State Historic Preservation Officer (SHPO) to substitute state review for Committee review (35 CFR 800.7). The results of this review are presented in Chapter 4.

C.2 THREATENED OR ENDANGERED SPECIES

Pursuant to Section 7 of the Endangered Species Act (16 USC 1531 et seq.), federal agencies are required to ensure that agency action is not likely to jeopardize any species that is listed or proposed for listing as endangered or threatened. Depending on the action involved, the Act requires consultation with the U.S. Fish and Wildlife Service (FWS) regarding effects on non-marine species, the National Marine Fisheries Service (NMFS) for marine species, or both. FWS and NMFS have issued joint procedural regulations at 50 CFR 402, Subpart B, that address consultation, and FWS maintains the joint list of threatened and endangered species at 50 CFR 17. An assessment of the effects on threatened or endangered species is presented in Chapter 4.

C.3 WATER QUALITY (401) CERTIFICATION

Under the Federal Clean Water Act, Section 401, applicants for a federal license to conduct an activity that might result in a discharge into navigable waters are required to provide the licensing agency a certification from the state that the discharge will comply with applicable Clean Water Act requirements (33 USC 1341). NRC has indicated in its Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants (GEIS) that issuance of a National Pollutant Discharge Elimination System (NPDES) permit implies certification by the state (NRC 1996e). The U.S. Environmental Protection Agency granted the State of Iowa authority to issue NPDES permits. FPL-DA is applying to NRC for license renewal to continue DAEC operations. Hydrological Impacts are presented in Chapter 4.

C.4 COASTAL ZONE MANAGEMENT PROGRAM COMPLIANCE

The Federal Coastal Zone Management Act (16 USC 1451 et seq.) imposes requirements on applicants for a federal license to conduct an activity that could affect a state's coastal zone. The Act requires an applicant to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program [16 USC 1456(c)(3)(A)]. The National Oceanic and Atmospheric Administration has promulgated implementing regulations indicating that the requirement is applicable to renewal of federal licenses for activities not previously reviewed by the state [15 CFR 930.51(b)(1)]. The regulation requires that the license applicant provide its certification to the federal licensing agency and a copy to the applicable state agency [15 CFR 930.57(a)]. Iowa is not included in the coastal zone management program and therefore this requirement is not applicable to DAEC.

TABLE C-1
Environmental Authorizations for Current DAEC Operations

Agency	Authority	Requirement	Issuance or Expiration Date
Federal and State Requirements			
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011, et seq.), 10 CFR 50.10	License to operate	Issued: 02/21/1974 Expires: 02/21/2014
U.S. Department of Transportation	49 USC 5108	Registration	Issued: 07/09/2008 Expires: 06/30/2011
U.S. Environmental Protection Agency	Federal Resource Conservation and Recovery Act (42 USC 6912)	Notification of Regulated Waste Activity	NA
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:71	Permit for water intake and discharge structures and low head dam on Cedar River	Issued: 08/06/1971
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:50-51	Permit to store water in Pleasant Creek Reservoir and withdraw water from Cedar River	Issued: 03/14/2004 Expires:03/13/2014
Iowa Department of Natural Resources	Clean Water Act Section 401 (33 U.S.C. 1341)	Water Quality Certification	Issued: 08/26/2005
U.S. Army Corps of Engineers	Rivers and Harbors Act of 1899 Section 10 (33 U.S.C. 403) Clean Water Act Section 404 (33 U.S.C. 1344) Marine Protection, Research and Sanctuaries Act of 1972 Section 103 (33 U.S.C. 1413)	Dredging Permit	Issued: 09/20/2005 Expires: 12/31/2010
Linn County	Linn County Flood Plain Management Regulations	Flood Plain Development Permit	Issued: 12/04/2007 Expires: 12/04/2008

Agency	Authority	Requirement	Issuance or Expiration Date
Iowa Department of Natural Resources	Code of Iowa Chapter 461A	Sovereign Lands Construction Permit	Issued: 10/10/2006 Expires:12/31/2008
Iowa Department of Natural Resources	Code of Iowa Chapter 461A	Sovereign Lands Construction Permit	Issued: 11/07/2007 Expires:12/31/2009
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:50-51	Operator certification	Issued: 08/29/2007 Expires: 06/30/2009
Iowa Department of Natural Resources	Clean Water Act (33 USC Section 1251 et seq.), Iowa Code 455B.174, IAC 567-64.3	NPDES Permit	Issued: 07/06/2007 Expires: 07/05/2009
Linn County	Federal Clean Air Act (42 USC 7661-7671), Iowa Code 455B:567, IAC 20-31, LCCO 10.5	Air Operation Permit	Expires 11/10/2008
Iowa Department of Public Health	Iowa Homeland Security Emergency Management	Transportation Service License	Issued: 06/25/2007 Expires: 06/30/2009
Iowa Department of Natural Resources	Code of Iowa Chapter 455B and part 567	Permit to operate public water system	Issued: 11/21/2006 Expires: 12/31/2009
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:50-51	Permit to operate 4-well system for potable water	Issued: 07/01/2002 Expires: 06/30/2012
Iowa Department of Natural Resources	IAC 467-135.1(3)c	Deferral of UST regulation to NRC	NA
Tennessee Department of Environment and Conservation	Tennessee Code Annotated 68-202-206	License to ship Radioactive material	Expires: 12/31/2008
Utah Department of Environmental Quality	Utah Rule 313-26	License to ship Radioactive material	Expires: 10/27/2008

NA- Not Applicable NRC – Nuclear Regulatory Commission
US- United States Code IAC – Iowa Administrative Code
LCCO – Linn County Code of Ordinances NPDES – National Pollutant Discharge Elimination System UST – Underground Storage Tank

TABLE C-2
Environmental Authorizations for DAEC License Renewal

Agency	Authority	Requirement	Remarks
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011 et seq.)	License renewal	Environmental Report submitted in support of license renewal Application
U.S. Fish and Wildlife Service	Endangered Species Act Section 7 (16 USC 1536)	Consultation	Requires federal agency issuing a license to consult with the FWS (Appendix C)
Iowa Department of Natural Resources	Endangered and Threatened Species Laws (State Statute 29.604 & Administrative Rule NR 27)	Endangered Resources Review	Review explains what rare species, natural communities, or natural features tracked in the Natural Heritage Inventory database are found in or near the proposed project area. And any additional steps to assure compliance with the Iowa endangered species protection laws and regulations. (Attachment C)
Iowa Department of Natural Resources	Clean Water Act Section 401 (33 USC 1341)	Certification	Requires State certification that proposed action would comply with Clean Water Act standards
Iowa Historic Preservation Office	National Historic Preservation Act Section 106 (16 USC 470f)	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with State Historic Preservation Officer (Attachment D)

Appendix D

Consultation Correspondence

D. Consultation Correspondences

The Endangered Species Act of 1973, as amended, the Magnuson-Stevens Fisheries Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups prior to taking action that may affect threatened and endangered species, essential fish habitat, or historic and archaeological resources, respectively. This appendix contains consultation documentation.

Table D-1. Consultation Correspondences. *This is a list of the consultation documents sent between the NRC and other agencies we are required to consult with based on NEPA requirements.*[(a)]

Author	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission	Iowa Department of Natural Resources (W. Gleselman)	May 6, 2009
U.S. Nuclear Regulatory Commission	National Oceanographic and Atmospheric Administration, National Marine Fisheries Service (R. Crabtree)	May 6, 2009
U.S. Nuclear Regulatory Commission	U.S. Fish and Wildlife Service, Region 3 (T. Melius)	May 6, 2009
U.S. Nuclear Regulatory Commission	Iowa Office of the State Archaeologist, State Archaeologist (J. Doershuck)	May 7, 2009
U.S. Nuclear Regulatory Commission	Advisory Council on Historic Preservation (C. Vuaghin)	May 7, 2009
U.S. Nuclear Regulatory Commission	Historic Preservation Officer State Historical Society of Iowa (J. Thompson)	May 7, 2009
U.S. Nuclear Regulatory Commission	ITC Midwest, LLC	September 28, 2009
Iowa Department of Natural Resources	U.S. Nuclear Regulatory Commission	May 18, 2009
U.S. Fish and Wildlife Service	U.S. Nuclear Regulatory Commission	May 29, 2009

(a) Similar letters went to nineteen Native American Tribes listed in Section 1.8.

D.1 Consultation Correspondence

The following pages contain copies of the letters listed in Table D-1.

May 6, 2009

Mr. Wayne Gieselman, Administrator
Iowa Department of Natural Resources
Environmental Services Division
502 East 9th Street
Des Moines, IA 50319.

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND WATER USAGE IMPACTS WITHIN THE AREA UNDER EVALUATION FOR THE DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Gieselman:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by FPL Energy Duane Arnold, LLC for the renewal of the operating license for Duane Arnold Energy Center (DAEC). The DAEC is located in Linn County, Iowa on the western bank of the north-south reach of the Cedar River, approximately two miles north-northeast of the town of Palo and approximately three miles east of the Benton county line. As part of the review of the license renewal application, the NRC is preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act (NEPA) of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species, fish and wildlife, and water usage. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

FPL Energy Duane Arnold, LLC has stated that it has no plans to alter current operations over the license renewal period. Operating under a renewed license, the DAEC would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. Any maintenance activities would be limited to previously disturbed areas.

The DAEC site encompasses approximately 500 acres of land. The site is located on a strip of land running northeast and parallel to the Cedar River, which is the largest tributary of the Iowa River. The slopes are heavily wooded, but transition into gently rolling farmland as one moves away from the immediate vicinity of the river. Aquatic communities of the Cedar River in the vicinity of DAEC are directly influenced by the quantity and quality of water in the river, which is the source of makeup water for the plant's mechanical draft cooling towers. Approximately 25 percent (126 acres) of the current site is leased farmland. The remainder of the site is a combination of small forested plots, a marsh and hardwood forest along the river, and the industrial plant complex (See Enclosed Map).

The plant employs a closed-cycle heat dissipation system with cooling towers, designed to remove waste heat from the Circulating Water System, which cools the main condensers. The intake structure is located on the west bank of the Cedar River. Makeup water for the

Circulating Water System is provided by the River Water Supply System, which includes the intake structure, intake pumps, and various features to control the amount of debris entering the system (See Enclosed Map).

Five transmission lines were built to connect DAEC to the electric grid. Two 345-kV lines tie into an existing 345-kV line, and three 161-kV lines deliver power to three substations at Washburn, Bertram, and Hiawatha (AEC 1973). An additional 161-kV line was later added to this system. The transmission system is summarized below (see enclosed map).

- Hills 345-kV Line – A single circuit line, which runs westward from DAEC along a 665-foot wide corridor shared with the Hazelton line, the Washburn Line, and for approximately 0.34 miles, the Bertram line. After the Bertram line splits off, the corridor becomes 500 feet wide. The Hills line runs approximately 2.7 miles and then turns south to the Hills substation feed, an existing line running in the north-south direction approximately 3.5 miles west of the site.
- Hazelton 345-kV Line – A single circuit line, which runs westward from DAEC in a 665-foot wide corridor shared with the Hills line, the Washburn Line, and for approximately 0.34 miles the Bertram line. After the Bertram line splits off, the corridor becomes 500 feet wide. This line runs approximately 2.7 miles and turns north to the Hazelton substation to feed an existing line, which runs in a north-south direction approximately 3.5 miles west of the site.
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- Hiawatha 161-kV Line – A single circuit line, which leaves the site in an easterly direction, crosses the Cedar River, and continues eight miles to the Hiawatha substation.
- Sixth Street 161-kV Line – A single circuit line, which leaves the site in a southwesterly direction around Palo, then follows a railroad corridor 16 miles southeast to the center of Cedar Rapids proper.

W. Gieselman - 3 –

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be within the vicinity of Duane Arnold Energy Center and its associated transmission line right-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Please also provide any information regarding water usage impacts. To support the project schedule, we request that this information be transmitted by June 1, 2009.

On June 15, 2009, we plan to conduct an audit of the DAEC site. You and your staff are invited to attend this audit. Your office will also receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is January 29, 2010. If you would like to submit any comments regarding the scope of this SEIS, or have any questions, please contact Charles Eccleston, Environmental Project Manager, by phone at 301-415-8537 or by email at Charles.Eccleston@nrc.gov, or Mr. Maurice Heath by phone at 301-415-3137 or by e-mail at Maurice.Heath@nrc.gov.

Sincerely,

/RA/

David L. Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosures:
1. Duane Arnold Site Description
2. Duane Arnold Site Boundary Map
3. Duane Arnold 6 Mile Vicinity Map
4. Duane Arnold Transmission System

cc w/encls: See next page

Duane Arnold Energy Center Site Description

SITE DESCRIPTION

The Duane Arnold Energy Center (DAEC) site is located on the western side of a north-south reach of the Cedar River, approximately 2.5 miles north-northeast of the Village of Palo, Iowa, in Linn County (T-84N, R-8W, Sections 9 and 10). The closest city is Cedar Rapids with its outer boundary being 8 miles to the southeast. The site is approximately 500 acres in size, on a flat strip of land running northeast and parallel to the Cedar River. The distance from the plant stack to the nearest site boundary is approximately 440 meters (m). A paved county highway provides access to the site.

TOPOGRAPHY

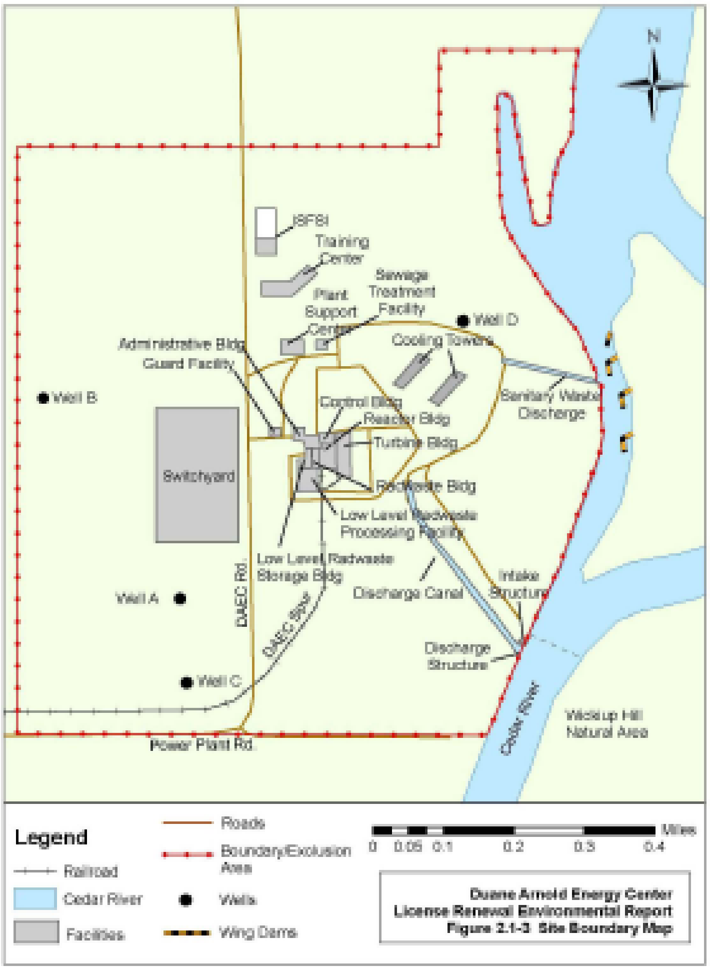
A relatively flat plain approximate 750 feet (ft) above mean sea level (msl) extends from the site toward the village of Palo on the southwest, and most of this land is now being farmed. At Palo, the elevation is 747 to 750 ft. Across the river from the site, the land rises from an elevation of 750 ft to an elevation of about 900 ft within a horizontal distance of approximately 2000 ft. These slopes are rather heavily wooded with only an occasional field or pasture dotting the landscape. Beyond this rise, the land is gently rolling farmland. To the northwest, the land rises to an elevation of 850 ft. Adjacent to the east is another heavily wooded low area that constitutes the current flood plain. This area is flat and extends approximately 1500 ft to the west bank of the river. The general topographical features in this portion of the Cedar River consist of broad valleys with relatively narrow flood plains. In many places, these broad valleys merge almost imperceptibly into the adjacent uplands. Away from the immediate vicinity of the river, the land is gently rolling farmland.

TRANSMISSION LINE CORRIDORS

Five transmission-line systems extend westward in a 665-ft wide corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near *this* road, two 161-kV lines depart and continue within a 100-ft basic width corridor (generally narrower along railroad and public rights-of way) in a southerly direction. At the village of Palo, one of these lines follows a railroad right-of-way in a southeasterly direction to the Sixth Street substation in Cedar Rapids. The total distance of this line is 11.2 miles. The other 161-kV line continues in a southerly direction west of Cedar Rapids and then eastward, via Fairfax, to the Bertram substation. The total distance is 28 miles. The remaining 161-kV line and two 345-kV lines continue along a 500-ft wide corridor for a distance of 1.7 miles beyond the county road in a westerly direction. There, one 345 line turns south to the Hills substation, the other 345 line turns north to the Hazelton substation. The 161-kV line continues for a distance of 16 miles to the Garrison substation and then an additional 30 miles to the Washburn substation. A sixth transmission line leaves the plant site in a generally easterly direction, crosses the Cedar River, and continues for a distance of 8 miles to the Hiawatha substation.

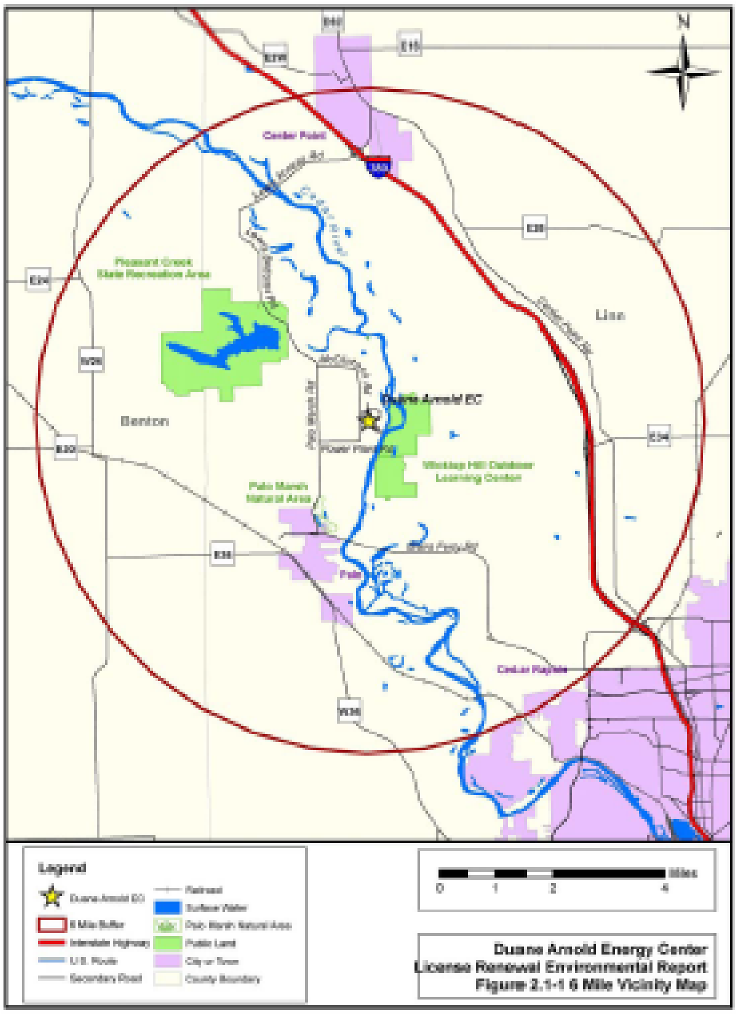
ENCLOSURE 1

Duane Arnold Site Boundary Map



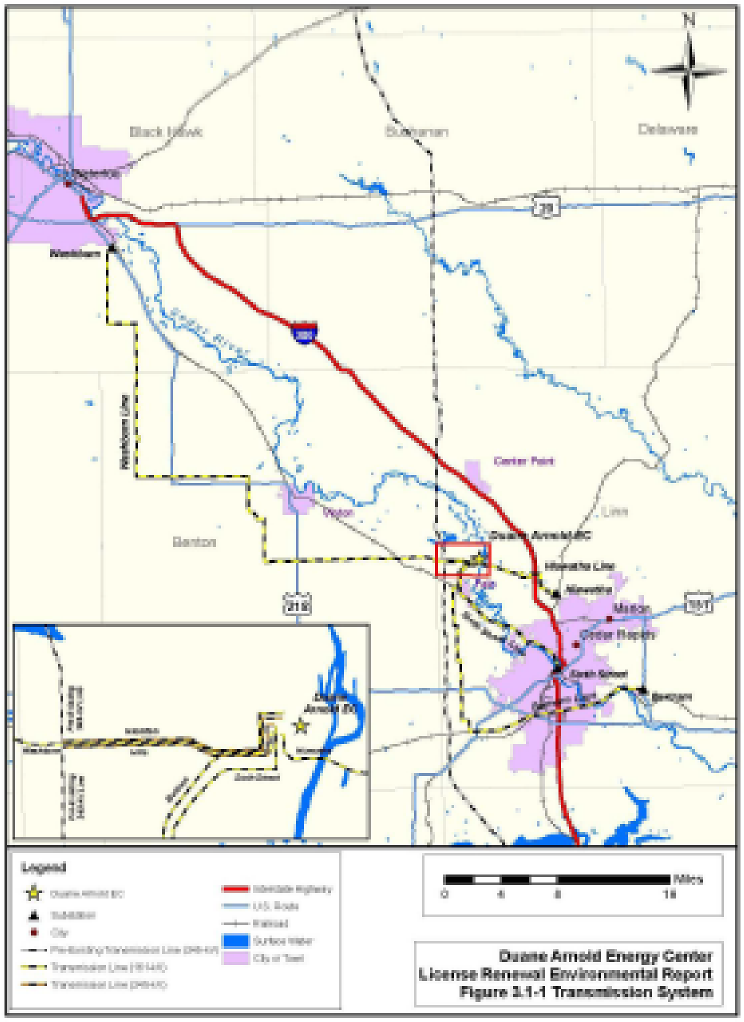
ENCLOSURE 2

Duane Arnold 6-Mile Vicinity Map



ENCLOSURE 3

Duane Arnold Transmission System



ENCLOSURE 4

May 6, 2009

Dr. Roy Crabtree
NOAA
National Marine Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND ESSENTIAL FISH HABITAT WITHIN THE AREA UNDER EVALUATION FOR THE DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

Dear Dr. Crabtree:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by FPL Energy Duane Arnold, LLC for the renewal of the operating license for Duane Arnold Energy Center (DAEC). The DAEC is located in Linn County, Iowa on the western bank of the north-south reach of the Cedar River, approximately two miles north-northeast of the town of Palo and approximately three miles east of the Benton county line. As part of the review of the license renewal application, the NRC is preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act (NEPA) of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species, and impacts to marine resources and habitat. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended, and the Sustainable Fisheries Act of 1996.

FPL Energy Duane Arnold, LLC has stated that it has no plans to alter current operations over the license renewal period. Operating under a renewed license, the DAEC would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. Any maintenance activities would be limited to previously disturbed areas.

The DAEC site encompasses approximately 500 acres of land. The site is located on a strip of land running northeast and parallel to the Cedar River, which is the largest tributary of the Iowa River. The slopes are heavily wooded, but transition into gently rolling farmland as one moves away from the immediate vicinity of the river. Aquatic communities of the Cedar River in the vicinity of DAEC are directly influenced by the quantity and quality of water in the river, which is the source of makeup water for the plant's mechanical draft cooling towers. Approximately 25 percent (126 acres) of the current site is leased farmland. The remainder of the site is a combination of small forested plots, a marsh and hardwood forest along the river, and the industrial plant complex (See Enclosed Map).

The plant employs a closed-cycle heat dissipation system with cooling towers, designed to remove waste heat from the Circulating Water System which cools the main condensers. The intake structure is located on the west bank of the Cedar River. Makeup water for the Circulating Water System is provided by the River Water Supply System, which includes the intake structure, intake pumps, and various features to control the amount of debris entering the system (See Enclosed Map).

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To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of endangered, threatened, candidate, and proposed species, and designated and proposed critical habitat under the jurisdiction of the National Marine Fisheries Service that may be within the vicinity of the DAEC site and its transmission line corridors.

R. Crabtree - 3 -

In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also, in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of any essential fish habitat that has been designated in the vicinity of the Duane Arnold Energy Center site and its associated transmission line corridors. To meet the project schedule, we request that all information be transmitted by June 1, 2009.

On June 15, 2009, we plan to conduct an audit of the DAEC site. You and your staff are invited to attend this audit. Your office will also receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is January 29, 2010. If you would like to submit any comments regarding the scope of this SEIS, or have any questions, please contact the Project Managers, Charles Eccleston at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Maurice Heath at 301-415-3137 or by e-mail at Maurice.Heath@nrc.gov.

Sincerely,

/RA/

David L. Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

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cc w/encls: See next page

Duane Arnold Energy Center Site Description

SITE DESCRIPTION

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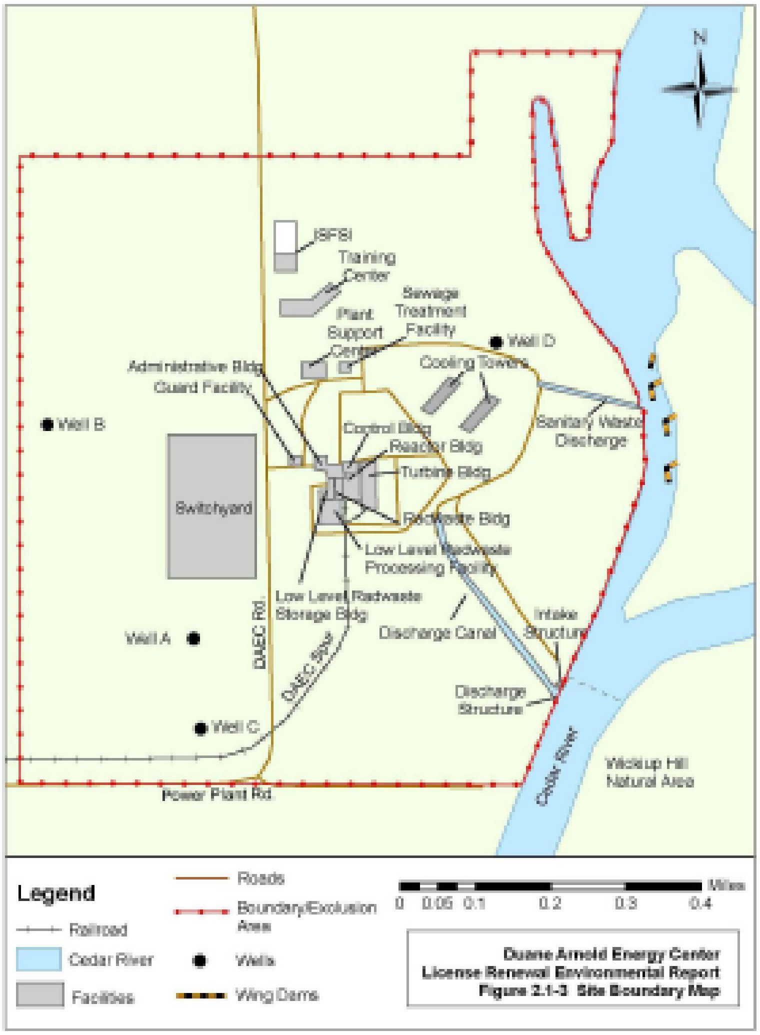

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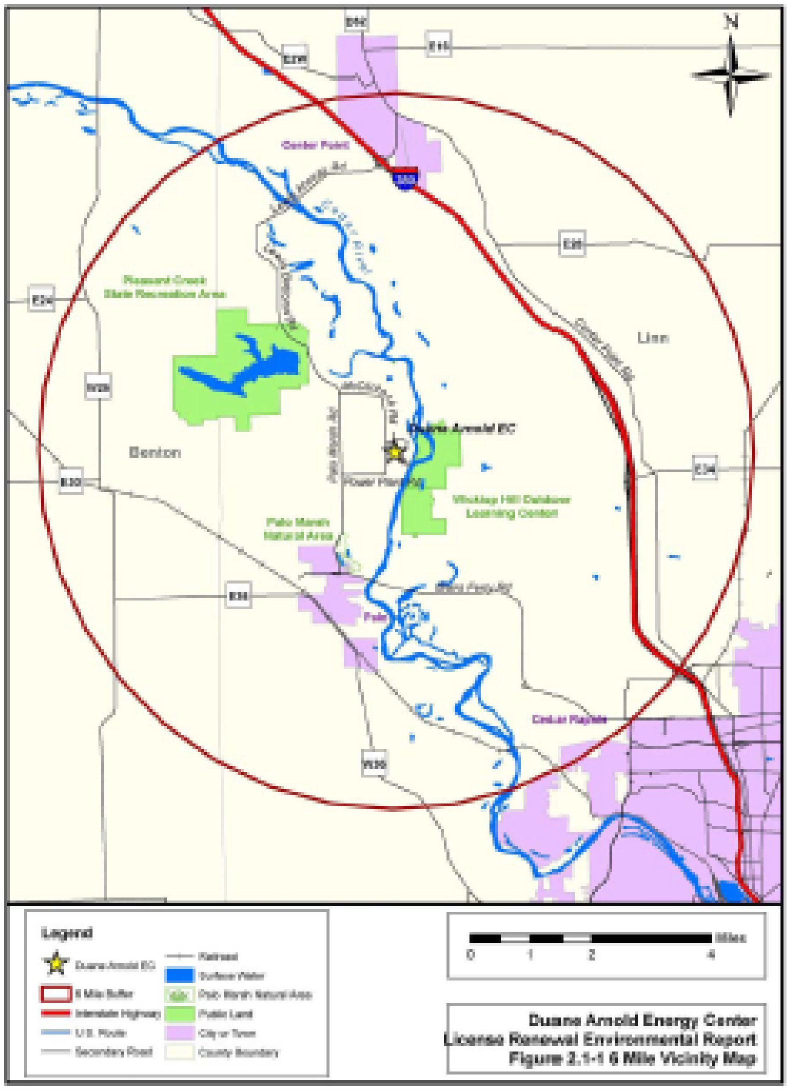

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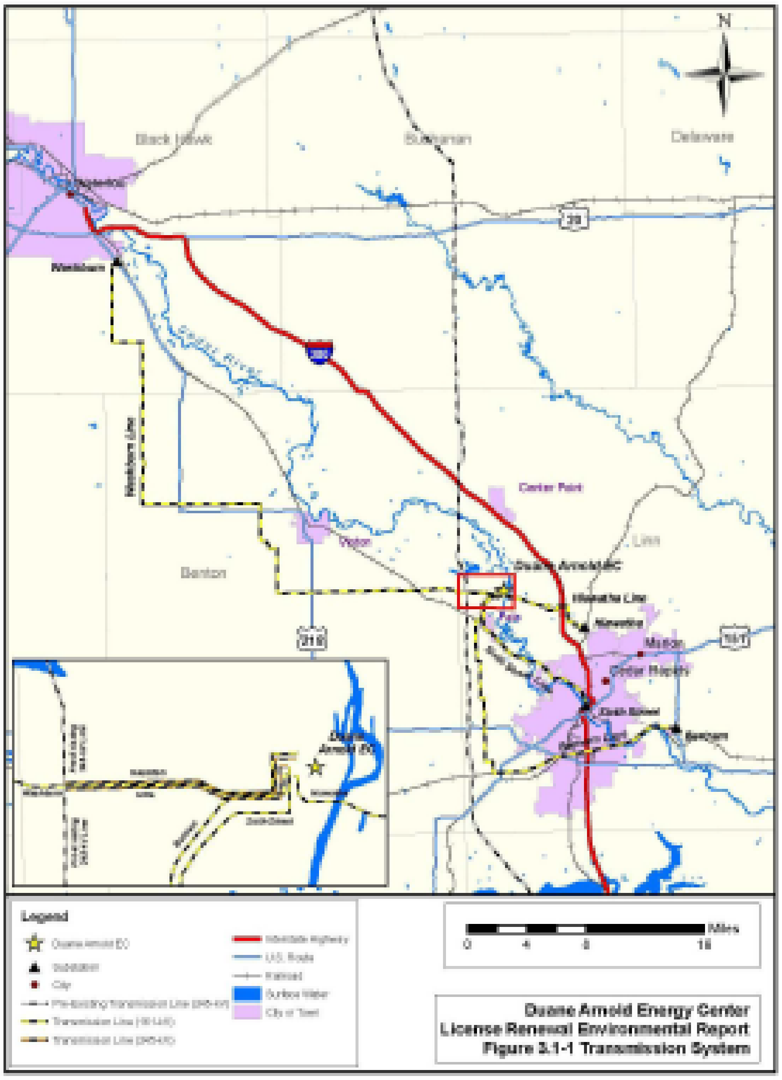

ENCLOSURE 4

May 6, 2009

Mr. Tom Melius, Regional Director
Region 3, U.S. Fish and Wildlife Service
One Federal Drive
BHW Federal Building
Fort Snelling, MN 55111

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

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Sincerely,

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David L. Pelton, Chief
Projects Branch 1
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Docket No. 50-331

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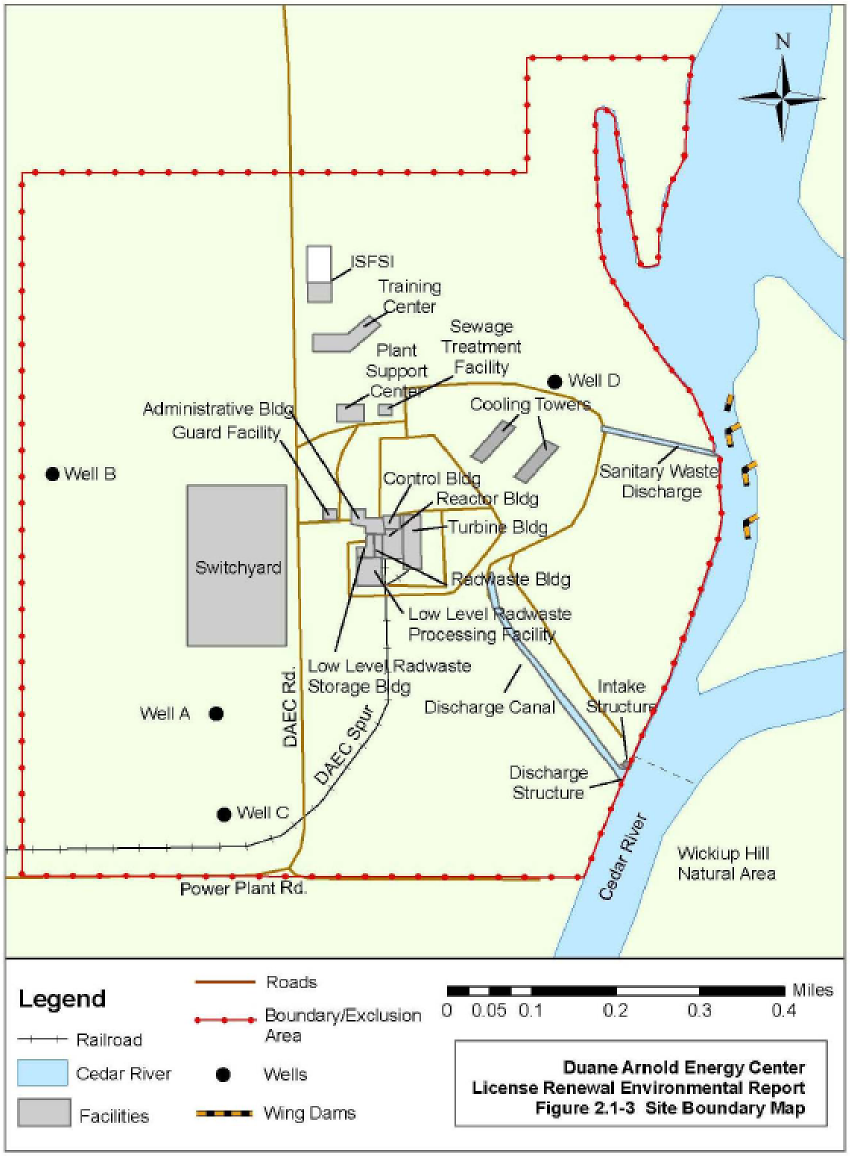

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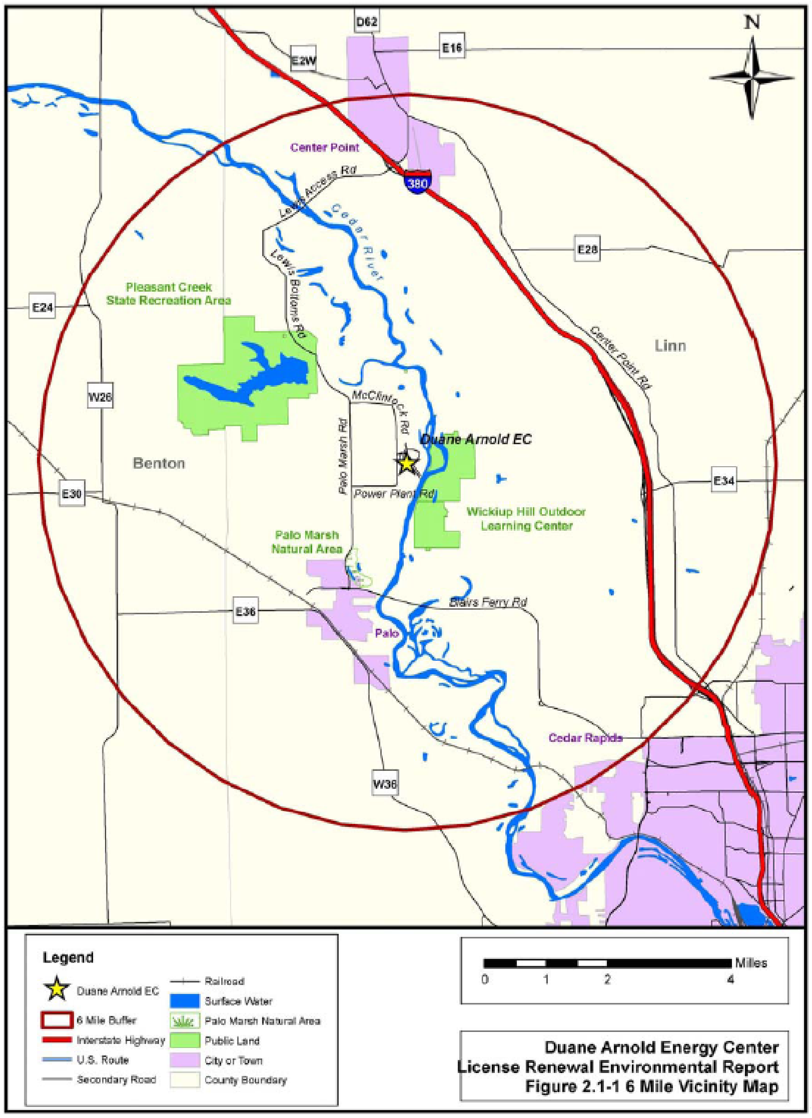
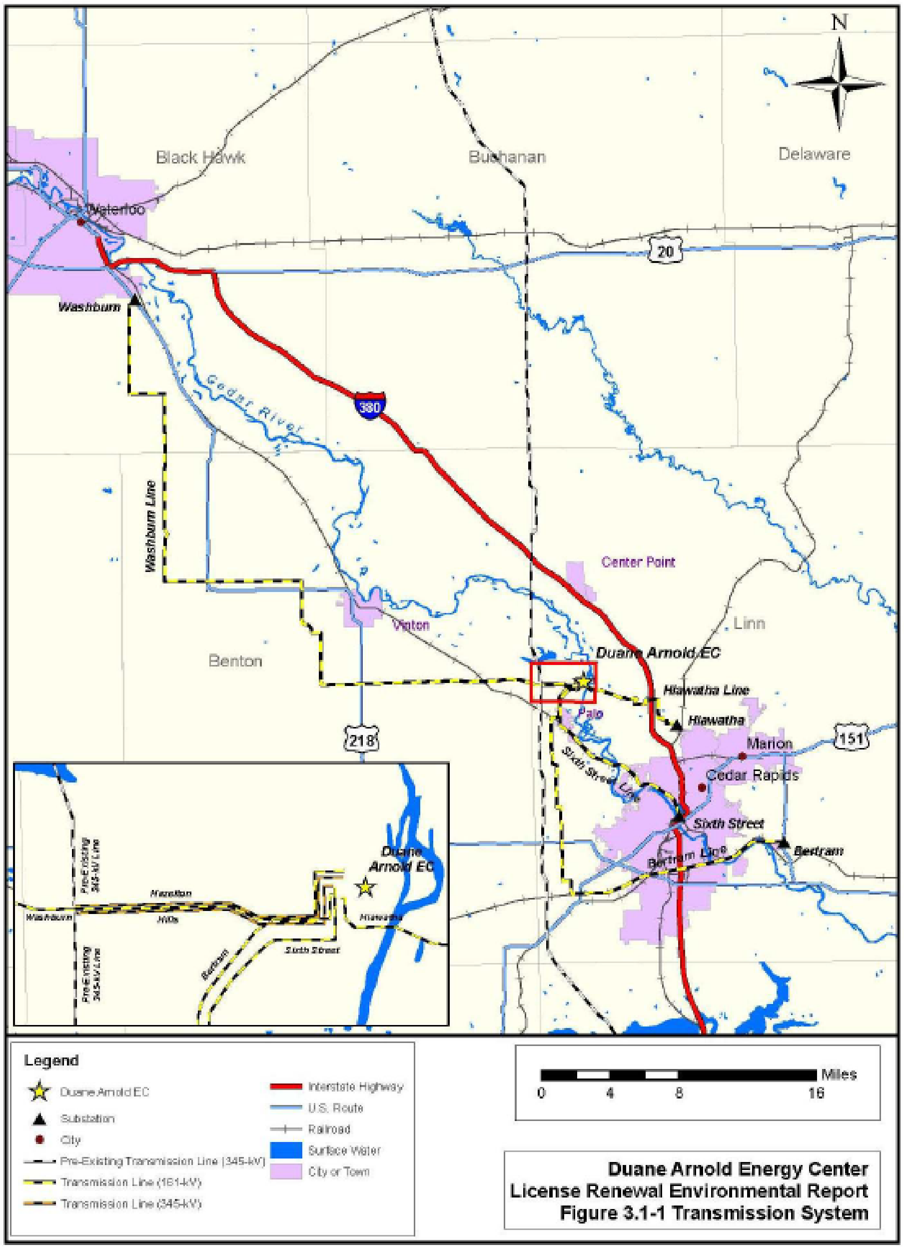


ENCLOSURE 3

Duane Arnold Transmission System



Duane Arnold Energy Center
License Renewal Environmental Report
Figure 3.1-1 Transmission System

ENCLOSURE 4

May 7, 2009

Mr. John Doershuck
State Archaeologist
Office of the State Archaeologist
700 South Clinton Street Building
University of Iowa
Iowa City, IA 52242-1030

SUBJECT: DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Doershuck:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for the Duane Arnold Energy Center (DAEC), which is located near Cedar Rapids, IA. The DAEC is operated by FPL Energy Duane Arnold, LLC. The application for renewal was submitted by FPL Energy Duane Arnold, LLC on September 30, 2008, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). Neither operational, refurbishment, nor major replacement activities are planned as a result of the proposed license renewal action that will impact previously undisturbed land.

The NRC has established that, as part of the staff review of any nuclear power plant license renewal action, a site-specific supplemental environmental impact statement (SEIS) to its Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and cultural resources. A draft SEIS is scheduled for publication in January 29, 2010, and will be provided to you for review and comment.

On June 15, 2009, we plan to conduct an audit of the DAEC site. You and your staff are invited to attend this audit. Your office will also receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is January 29, 2010. If you would like to provide any comments regarding the scope of this SEIS, please provide them by June 1, 2009.

J. Doershuck - 2 -

If you have any questions, please contact Charles Eccleston, Environmental Project Manager, by phone at 301-415-8537 or by email at Charles.Eccleston@nrc.gov, or Maurice Heath at 301-415-3137 or by e-mail at Maurice.Heath@nrc.gov.

Sincerely,

/RA/

David Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

Cc w/encls: See next page

Enclosures:
1. Duane Arnold Site Description
2. Duane Arnold Site Boundary Map
3. Duane Arnold 6-Mile Vicinity Map
4. Duane Arnold Transmission System

cc w/encls: See next page

Duane Arnold Energy Center Site Description

SITE DESCRIPTION
The Duane Arnold Energy Center (DAEC) site is located on the western side of a north-south reach of the Cedar River, approximately 2.5 miles north-northeast of the Village of Palo, Iowa, in Linn County (T-84N, R-8W, Sections 9 and 10). The closest city is Cedar Rapids with its outer boundary being 8 miles to the southeast. The site is approximately 500 acres in size, on a flat strip of land running northeast and parallel to the Cedar River. The distance from the plant stack to the nearest site boundary is approximately 440 meters (m). A paved county highway provides access to the site.

TOPOGRAPHY

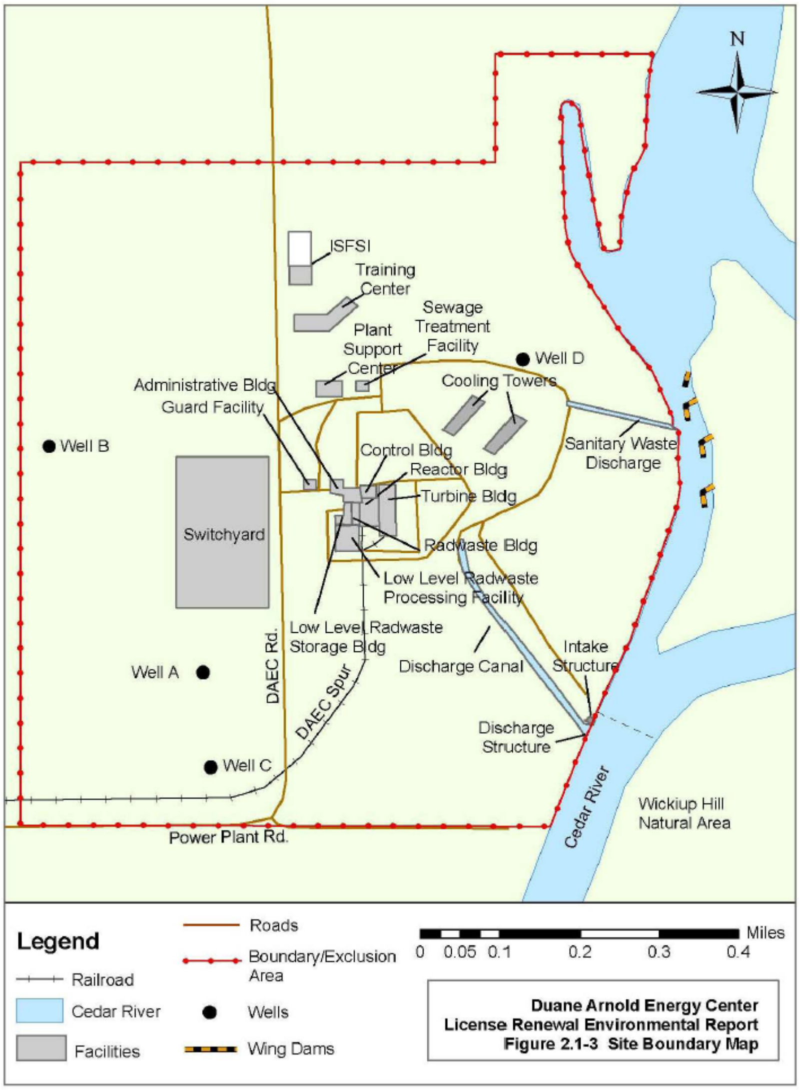
A relatively flat plain approximate 750 feet (ft) above mean sea level (msl) extends from the site toward the village of Palo on the southwest, and most of this land is now being farmed. At Palo, the elevation is 747 to 750 ft. Across the river from the site, the land rises from an elevation of 750 ft to an elevation of about 900 ft within a horizontal distance of approximately 2000 ft. These slopes are rather heavily wooded with only an occasional field or pasture dotting the landscape. Beyond this rise, the land is gently rolling farmland. To the northwest, the land rises to an elevation of 850 ft. Adjacent to the east is another heavily wooded low area that constitutes the current flood plain. This area is flat and extends approximately 1500 ft to the west bank of the river. The general topographical features in this portion of the Cedar River consist of broad valleys with relatively narrow flood plains. In many places, these broad valleys merge almost imperceptibly into the adjacent uplands. Away from the immediate vicinity of the river, the land is gently rolling farmland.

TRANSMISSION LINE CORRIDORS

Five transmission-line systems extend westward in a 665-ft wide corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near *this* road, two 161-kV lines depart and continue within a 100-ft basic width corridor (generally narrower along railroad and public rights-of way) in a southerly direction. At the village of Palo, one of these lines follows a railroad right-of-way in a southeasterly direction to the Sixth Street substation in Cedar Rapids. The total distance of this line is 11.2 miles. The other 161 kV line continues in a southerly direction west of Cedar Rapids and then eastward, via Fairfax, to the Bertram substation. The total distance is 28 miles. The remaining 161-kV line and two 345-kV lines continue along a 500-ft wide corridor for a distance of 1.7 miles beyond the county road in a westerly direction. There, one 345 line turns south to the Hills substation, the other 345 line turns north to the Hazelton substation. The 161-kV line continues for a distance of 16 miles to the Garrison substation and then an additional 30 miles to the Washburn substation. A sixth transmission line leaves the plant site in a generally easterly direction, crosses the Cedar River, and continues for a distance of 8 miles to the Hiawatha substation.

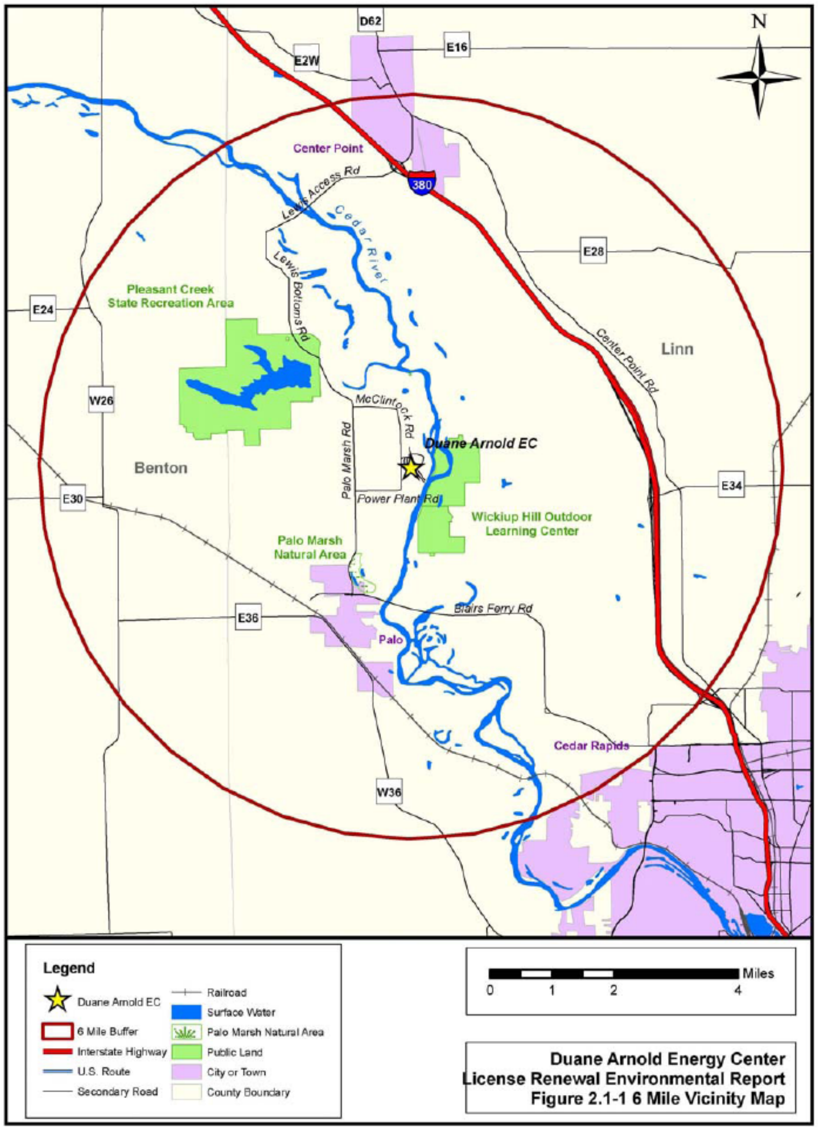
ENCLOSURE 1

Duane Arnold Site Boundary Map



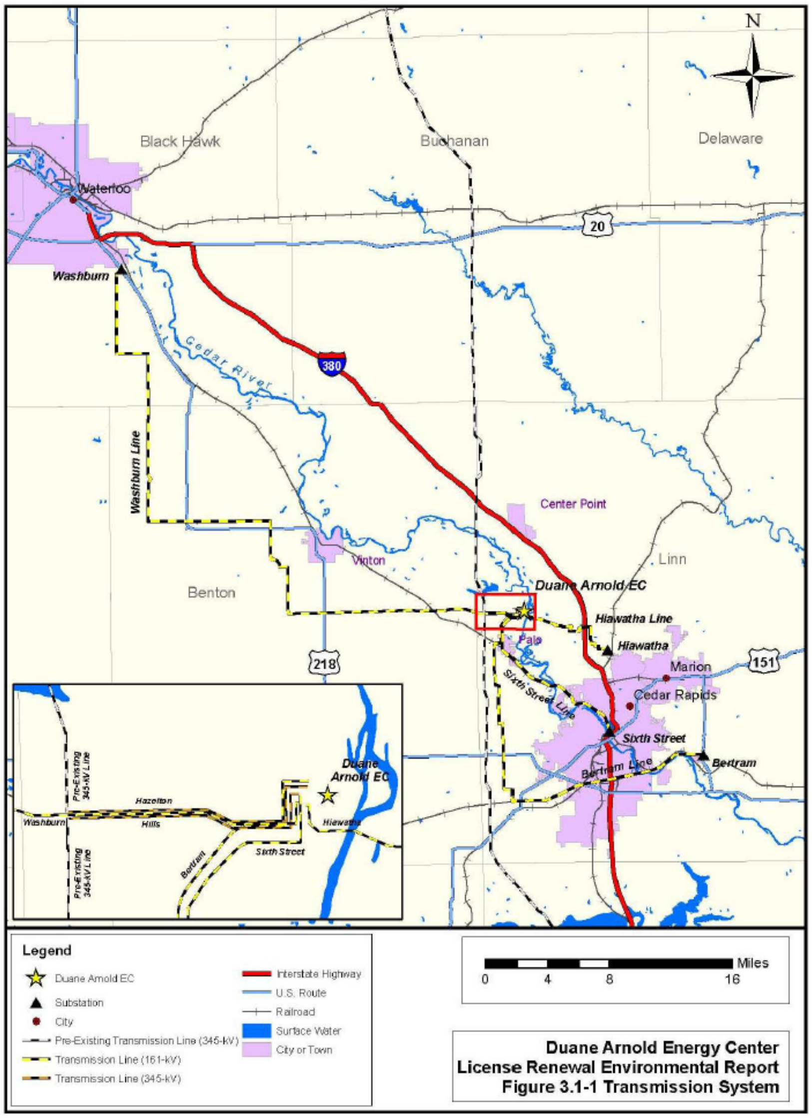
ENCLOSURE 2

Duane Arnold 6-Mile Vicnity Map



ENCLOSURE 3

Duane Arnold Transmission System



Duane Arnold Energy Center
License Renewal Environmental Report
Figure 3.1-1 Transmission System

ENCLOSURE 4

May 7, 2009

Ms. Charlene Dwin Vaughn, Assistant Director
Federal Permitting, Licensing, and Assistance
Section
Advisory Council on Historic Preservation
Old Post Office Building
1100 Pennsylvania Ave, NW, Suite 803
Washington, DC 20004

SUBJECT: DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Vaughn:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for the Duane Arnold Energy Center (DAEC), which is located near Cedar Rapids, IA. The DAEC is operated by FPL Energy Duane Arnold, LLC. The application for renewal was submitted by FPL Energy Duane Arnold, LLC on September 30, 2008, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). Neither operational, refurbishment, nor major replacement activities are planned as a result of the proposed license renewal action that will impact previously undisturbed land.

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C. Vaughn - 2 -

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Sincerely,

/RA/

David Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

cc w/encls: See next page

Enclosures:
1. Duane Arnold Site Description
2. Duane Arnold Site Boundary Map
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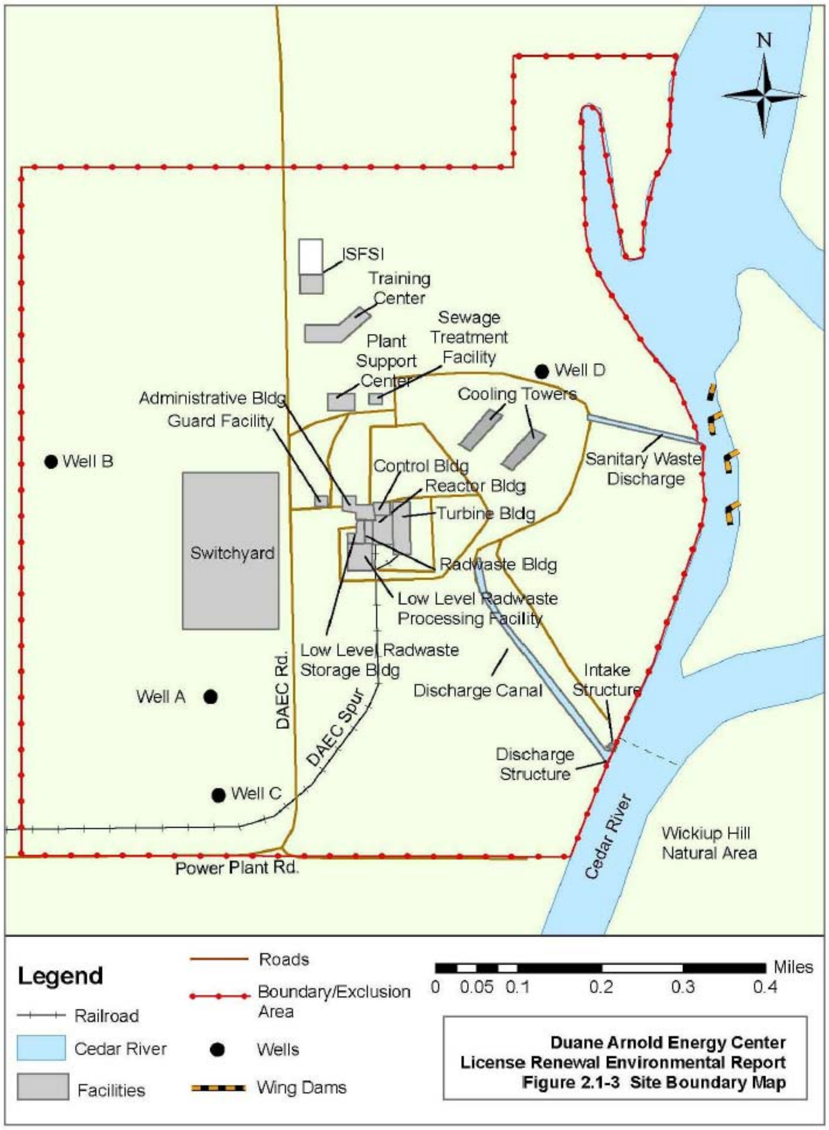
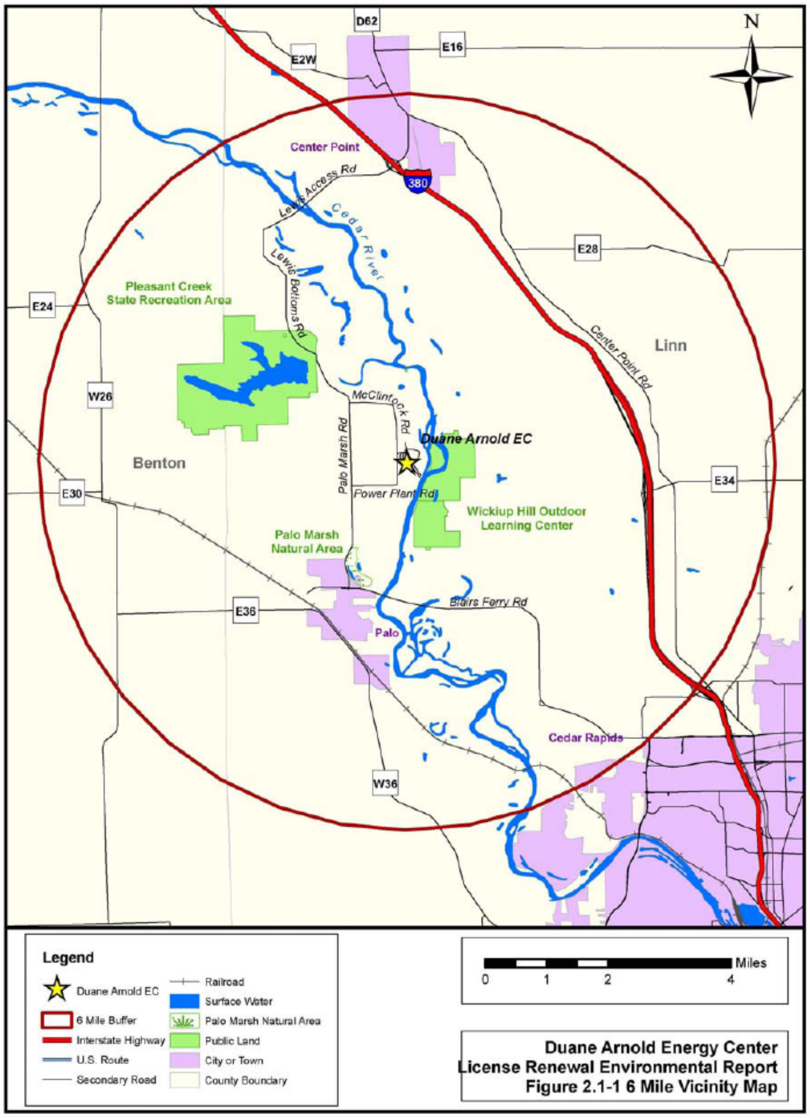


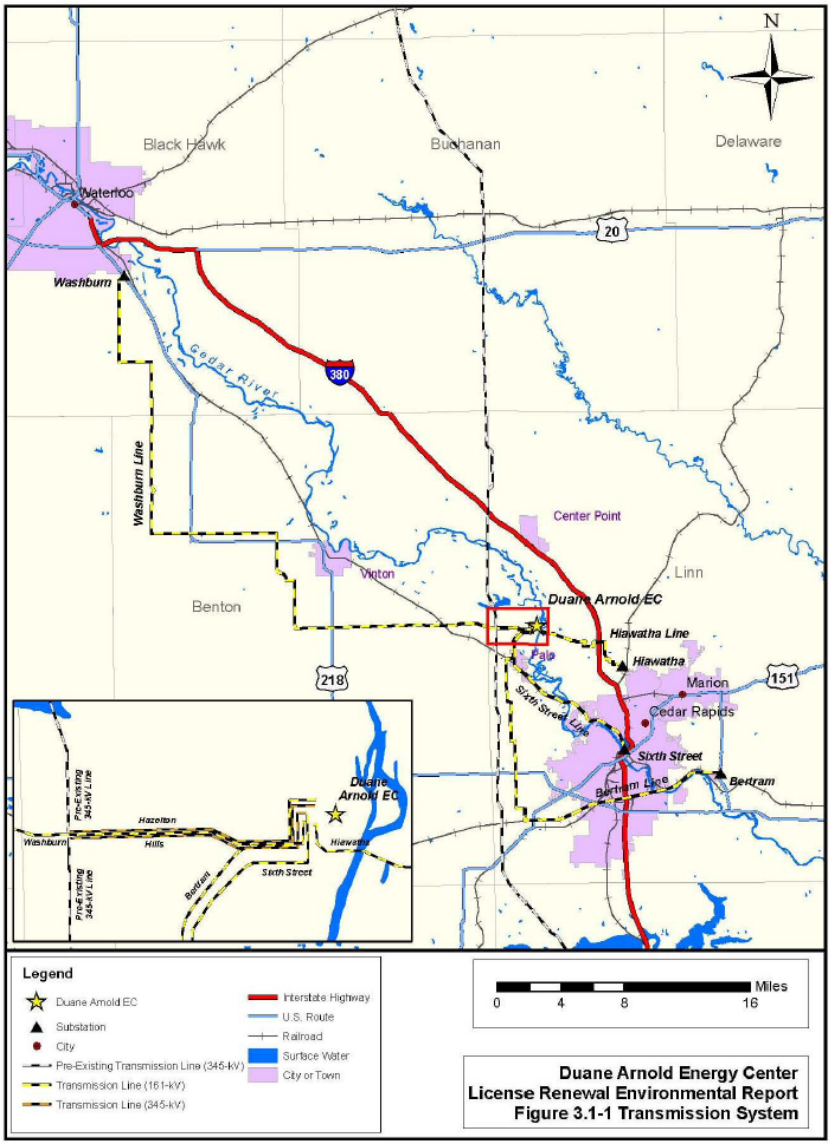
ENCLOSURE 2

Duane Arnold 6-Mile Vicinity Map



ENCLOSURE 3

Duane Arnold Transmission System



ENCLSOURE 4

May 7, 2009

Mr. Jerome Thompson, Interim State
 Historic Preservation Officer
State Historical Society of Iowa
600 East Locust Street
Des Moines, IA 50319

SUBJECT: DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Thompson:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for the Duane Arnold Energy Center (DAEC), which is located near Cedar Rapids, IA. The DAEC is operated by FPL Energy Duane Arnold, LLC. The application for renewal was submitted by FPL Energy Duane Arnold, LLC on September 30, 2008, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). Neither operational, refurbishment, nor major replacement activities are planned as a result of the proposed license renewal action that will impact previously undisturbed land.

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J. Thompson - 2 -

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Sincerely,

/RA/

David L. Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

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4. Duane Arnold Transmission System

cc w/encls: See next page

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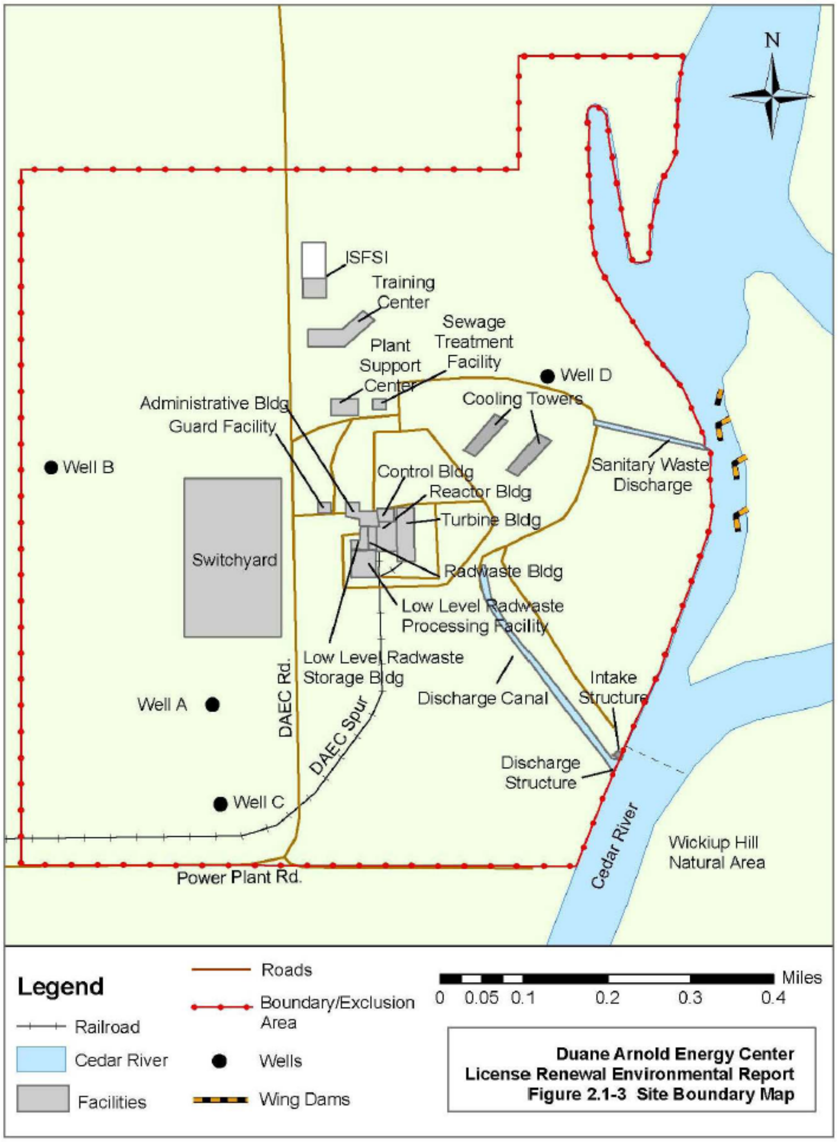
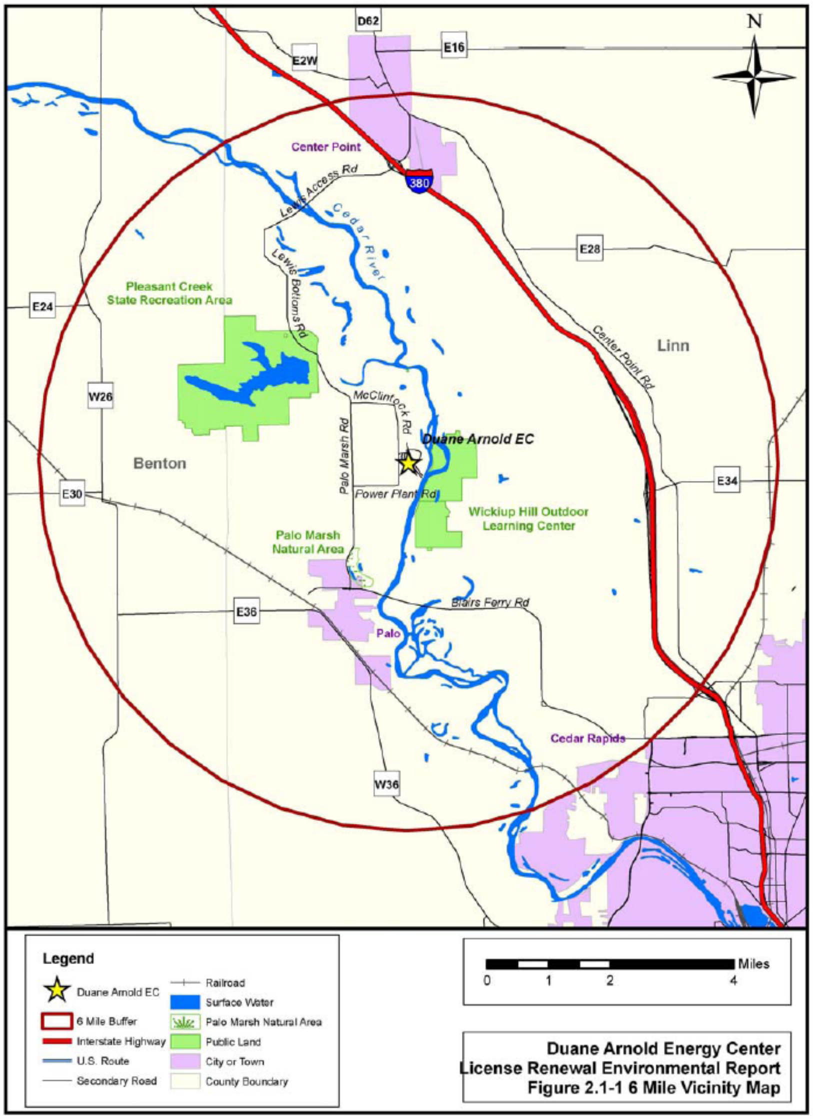


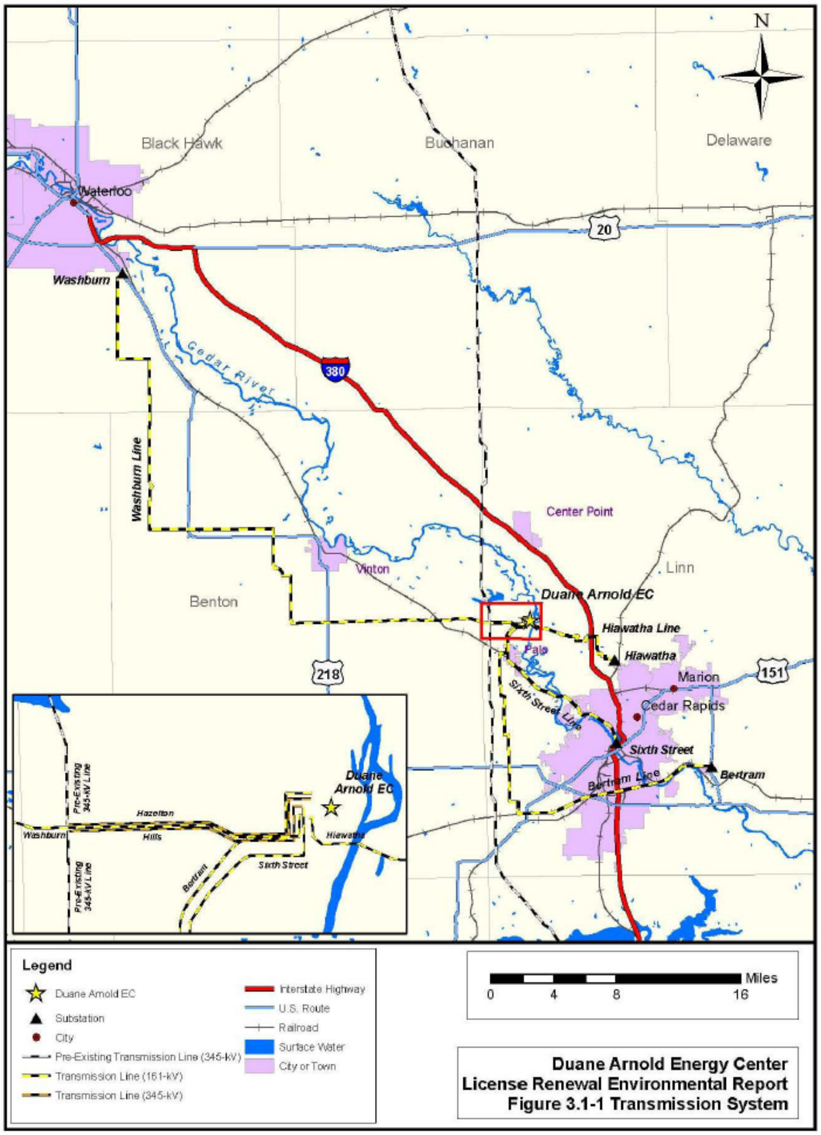
ENCLOSURE 2

Duane Arnold Site 6-Mile Vicinity Map



ENCLOSURE 3

Duane Arnold Transmission System



ENCLOSURE 4

September 28, 2009

Mr. Michael McNulty
ITC Midwest, LLC
27175 Energy Way
Novi, MI 48377

SUBJECT: DUANE ARNOLD ENERGY CENTER LICENSE RENEWAL APPLICATION REVIEW (TAC NO. MD9770)

Dear Mr. Nulty:

During the U.S. Nuclear Regulatory Commission's (NRC) review of the license renewal application by FPL Energy Duane Arnold, LLC, for Duane Arnold Energy Center (DAEC), the NRC found 12 historic and archaeological sites within the transmission lines. These transmission lines are associated with DAEC and are owned by ITC Midwest, LLC (ITC). These sites were identified during an archaeological records search at the offices of the Iowa Historic Preservation Office (SHPO) and the Office of the State Archaeologist (OSA). The purpose of this letter is to inform ITC of these archaeological sites so ITC can take the appropriate measures to consider these sites. In addition to the items listed in the table below, there is also the potential for prehistoric mounds to be in or near ITC transmission line rights-of-way. For more details about these sites, please contact SHPO and OSA. The following is a table of the sites found in the transmission line rights-of-way.

Historic and Archaeological Sites in the DAEC Associated Transmission Lines

Site Number	Cultural Affiliation	NRHP* Status
13LN81	Prehistoric	Unevaluated
13LN88	Woodland	Unevaluated
13LN139	Prehistoric/Historic	Unevaluated
13LN141	Prehistoric	Unevaluated
13LN167	Prehistoric	Unevaluated
13LN173	Prehistoric	Unevaluated
13LN183	Prehistoric	Unevaluated
13LN228	Prehistoric	Unevaluated
13LN362	Historic	Unevaluated
13LN380	Historic	Unevaluated
13LN465	Prehistoric	Unevaluated
13LN810	Historic	Unevaluated

*NRHP = National Register of Historic Places

Control of information on historic and archaeological resources in Iowa is split between the SHPO located in Des Moines, IA, and the OSA located in Iowa City, IA. Questions concerning the management of the resources should be directed to the SHPO while questons concering historic and archaeological site locations should be directed to the OSA. Points of contact are provided below:

Mr. Doug Jones
State Historic Society of Iowa
600 East Locust Street
Des Moines, IA 50317

Ms. Shirley Schermer
Office of the State of Archaeologist
700 South Clinton Street Building
University of Iowa
Iowa City, IA 52242-1030

If you have any questions, please contact Mr. Charles Eccleston, Project Manager, by telephone at 301-415-8537 or by e-mail at Charles.Eccleston @nrc.gov.

Sincerely,

/RA/

David L. Pelton, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-331

cc: See next page

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER TO:
FWS/RIFO

May 29, 2009

3/24/09
74FR12399
(2)

RECEIVED
2009 JUL 17 PM 3:28
RULES AND DIRECTIVES BRANCH USNRC

Mr. David K. Pelton
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Pelton:

This is in response to your letter of May 6, 2009, requesting a list of protected species within the area under evaluation for the Duane Arnold Energy Center license renewal application in Linn County, Iowa.

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the U.S. Fish and Wildlife Service (Service) information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action. Therefore, we are providing the following list of threatened and endangered species that may occur in the county of the proposed actions.

Classification	Common Name (Scientific Name)	Habitat
Threatened	Prairie Bush Clover (*Lespedeza leptostachya*)	Dry to mesic prairies with gravelly soil.
Threatened	Western Prairie Fringed Orchid (*Platanthera praeclara*)	Wet to mesic grasslands.

In addition, there have been recent efforts by the Service and the Iowa Department of Natural Resources to restore the endangered Higgins eye pearly mussel to the Cedar River, downstream of the project area. Target release areas and future plans for Higgins eye recovery in the area can be provided upon request, and we recommend that the Nuclear Regulatory Commission evaluate existing and potential project impacts to local water resources in relation to this recovery effort.

The project area is within the documented range of numerous species that are protected under the Migratory Bird Treaty act and/or have been identified by the Service as Resource Conservation Priorities (http://www.fws.gov/Midwest/EcosystemConservation/conservation_species.html). At a minimum, project evaluations should contain delineations of whether or not habitat for these species occurs within project boundaries or will be affected by project operations, particularly electrical transmission lines.

Finally, the proximity of the project area to the Cedar River provides a unique opportunity to augment local fish and wildlife resources through habitat restoration and environmentally friendly project operations. The Service would be pleased to provide information and assistance to the Nuclear Regulatory Commission and/or their representative during the relicensing process to develop ways to minimize project impacts to these resources and facilitate habitat restoration within the scope of the project.

This letter provides technical assistance and comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq).

If you have any questions regarding our comments or would like to arrange a meeting, please contact Amber Andress of my staff at (309) 757-5800 x 222.

Sincerely,

Richard C. Nelson
Field Supervisor

S:\Office Users\Amber\Technical Assistance
\Duane Arnold Nuclear License Renewal, 5-27-09

Fields of Opportunities

STATE OF IOWA

CHESTER J. CULVER, GOVERNOR
PATTY JUDGE, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
RICHARD A. LEOPOLD, DIRECTOR

May 18, 2009

3/24/09
74FR12399
(1)

RECEIVED
2009 JUL 17 PM 3:38
RULES AND DIRECTIVES BRANCH USNRC

David Pelton
US Nuclear Regulatory Commission
Division of License Renewal
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

RE: Environmental Review for Natural Resources
Duane Arnold Energy Center License Renewal Application Review
Linn County
Section 9, 10, Township 84N, Range 8W

Dear Mr. Pelton:

Thank you for inviting Department comment on the impact of this project. A review by Department staff of the Environmental Report Preliminary Draft, August 2007, submitted October 10, 2007, did not generate any water use concerns for the project. The Department searched for records of rare species and significant natural communities in the project area and found no site-specific records that would be impacted by the use of existing plant facilities and transmission lines. However, these records and data are not the result of thorough field surveys. If listed species or rare communities are found during the planning or construction phases, additional studies and/or mitigation may be required.

This letter is a record of review for protected species, rare natural communities, state lands and waters in the project area, including review by personnel representing state parks, preserves, recreation areas, fisheries and wildlife but does not include comment from the Environmental Services Division of this Department. This letter does not constitute a permit. Other permits may be required from the Department or other state or federal agencies before work begins on this project.

Any construction activity that bares the soil of an area greater than or equal to one acre including clearing, grading or excavation may require a storm water discharge permit from the Department. Construction activities may include the temporary or permanent storage of dredge material. For more information regarding this matter, please contact Ruth Rosdail at (515) 281-6782.

The Department administers regulations that pertain to fugitive dust IAW Iowa Administrative Code 567-23.3(2)"c." All persons shall take reasonable precautions to prevent the discharge of visible emissions of fugitive dusts beyond the lot line of property during construction, alteration, repairing or demolishing of buildings, bridges or other vertical structures or haul roads. All questions regarding fugitive dust regulations should be directed to Jim McGraw at (515) 242-5167.

If you have questions about this letter or require further information, please contact me at (515) 281-8967.

Sincerely,

Inga Foster
Inga Foster
Environmental Specialist
Conservation and Recreation Division

FILE COPY: Inga Foster
Tracking Number: 1803_2

CC: Christine Schwake, Iowa DNR
Christine Spackman, Iowa DNR

Appendix E

Chronology of Environmental Review

E. Chronology of Environmental Review Correspondence

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Three Mile Island Nuclear Station, Unit 1. All documents, with the exception of those containing proprietary information are available electronically from the NRC's Public Electronic Reading Room found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents in ADAMS. The ADAMS accession number for each document is included below.

E.1 Environmental Review Correspondence

September 30, 2008	Application submitted by FPL Energy Duane Arnold, LLC (FPL-DA) for renewal of Facility Operating License No. DPR-49 for an additional 20 years of operation at Duane Arnold Energy Center (DAEC).
February 17, 2009	United States Nuclear Regulatory Commission (NRC) issued "United states nuclear regulatory commission Notice of acceptance for docketing of the application and notice of opportunity for hearing regarding renewal of facility operating license no. Dpr-49 for an additional 20-year period, Duane arnold energy center docket no. 50-331"
March 24, 2009	NRC issued Notice of Intent to prepare an environmental Impact statement and conduct scoping process, Docket no. 50-331
May 6, 2009	Consultation letter to Robyn Thorson, Regional Director Region 3, U.S. Fish and Wildlife Service "Request For List Of Protected Species within the Area Under Evaluation For The Duane Arnold Energy Center License Renewal Application Review"
May 6, 2009	Consultation letter to Wayne Gieselman, Administrator Iowa Department of Natural Resources "Request For List Of Protected Species And Water Usage Impacts Within The Area Under Evaluation For The Duane Arnold Energy Center License Renewal Application Review"
May 6, 2009	Consultation letter to Patricia Kurkul, Regional Administrator, National Marine Fisheries Service, "Request for list of protected species and essential fish habitat within the area under evaluation for the (plant name, e.g. millstone power station, units 2 and 3) license renewal application review"
May 6, 2009	Letter to Christie Modlin, Chairperson Iowa Tribe of Oklahoma inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.

May 7, 2009	Consultation letter to Charlene Dwin Vaughn, Assistant Director Federal Permitting, Licensing, and Assistance Section Advisory Council on Historic Preservation
May 7, 2009	Consultation letter to John Doershuck State Archaeologist Office of the State Archaeologist
May 7, 2009	Consultation letter to Mr. Jerome Thompson, Interim-SHPO, State Historical Society of Iowa
May 14, 2009	George Thurman, Principal Chief Sac and Fox Nation of Oklahoma inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Fredia Perkins, Chairperson Sac and Fox Nation of Missouri inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Steve Ortiz, Chairman Prairie Band of Potawatomi Indians inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Joshua Weston, President Flandreau Santee Sioux Tribe inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Mr. Roger Trudell, Chairman Santee Sioux Nation inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to John Blackhawk, Chairman Winnebago Tribe of Nebraska inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Ronald Johnson, President Prairie Island Indian Community inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Stanley R. Crooks, Chairman Shakopee Mdewakanton Sioux Community of Minnesota inviting them to participate in the scoping process related to NRC's environmental review of the license application

	for the Duane Arnold Energy Center.
May 14, 2009	Letter to Kevin Jensvold, Chairman Upper Sioux Community of Minnesota inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to Wilfred Cleveland, President Ho-Chunk Nation inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 14, 2009	Letter to The Sac and Fox Tribe of the Mississippi: Adrian Pushetonequa, Chairman inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 26, 2009	Letter to Lori Nelson, Acting Lower Sioux Indian Community of Minnesota inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 26, 2009	Letter to Amen Sheriden, Chairman Omaha Tribal Council inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 26, 2009	Letter to Marlon E. Frye, Chairman Kickapoo Tribe of Oklahoma inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 26, 2009	Letter to John Shotton Otoe-Missouria Tribe of Indians inviting them to participate in the scoping process related to NRC's environmental review of the license application for the Duane Arnold Energy Center.
May 26, 2009	Letter to Leon Campbell, Chairman Iowa Tribe of Kansas and Nebraska inviting them to participate in the scoping process related to NRC's environmental review of the license application for the
June 17, 2009	Summary of public license renewal overview and environmental scoping meetings related to the review of the Duane Arnold Energy Center license renewal application (TAC No. MD 9770)
August 7, 2009	Issuance of environmental scoping summary report associated with the staff's review of the application for renewal of the operating license.

Appendix F

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Duane Arnold Energy Center in Support of License Renewal Application Review

F. U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR DUANE ARNOLD ENERGY CENTER IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F.1. Introduction

FPL Energy Duane Arnold, (FPL-DA) submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Duane Arnold Energy Center (DAEC) as part of the environmental report (ER) (FPL-DA, 2008). Supplemental information on the SAMA assessment was provided in response to a U.S. Nuclear Regulatory Commission (NRC) staff request (FPL-DA, 2009). This assessment was based on the most recent DAEC probabilistic risk assessment (PRA) available at that time, a plant-specific offsite consequence analysis using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code, and insights from the DAEC individual plant examination (IPE) (IELP, 1992) and individual plant examination of external events (IPEEE) (IES, 1995a). In identifying and evaluating potential SAMAs, FPL-DA considered SAMAs that addressed the major contributors to core damage frequency (CDF) as well as SAMA candidates for other operating plants that have submitted license renewal applications. FPL-DA initially identified 166 potential SAMAs. This list was reduced to 24 unique SAMA candidates by eliminating SAMAs that: are not applicable to DAEC due to design differences, have already been implemented at DAEC, are similar in nature and could be combined with another SAMA candidate, or have excessive implementation cost. FPL-DA assessed the costs and benefits associated with each of the potential SAMAs and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

F.1.1. Based on a review of the SAMA assessment, the NRC staff issued a request for additional information (RAI) to FPL-DA by letter dated June 25, 2009 (NRC, 2009a) and a request for RAI response clarification by letter dated August 24, 2009 (NRC, 2009b). Key questions concerned: the dominant contributors to CDF; clarification to the historical development of the Level 1 PRA; source term and release time category assignment assumptions used in the Level 2 and Level 3 analyses; additional details on the seismic and fire risk assessment models and their results; further information on the selection and screening of SAMA candidates; and further information on the cost benefit analysis of several specific candidate SAMAs and low cost alternatives. FPL-DA (under the name of NextEra Energy Duane Arnold, LLC) submitted additional information by letters dated July 9, 2009 (NextEra, 2009a) and September 23, 2009 (NextEra, 2009b). Corrections to the license renewal application were contained in an amendment to the application dated September 30, 2009 (NextEra, 2009c). In the responses, FPL-DA provided: a listing of the contribution to CDF by initiating an event and a tabulation of risk reduction worth (RRW) importance; clarification of PRA revision dates and CDF results; a discussion of the Level 2 analysis and the process for assigning severe accident source terms and binning release categories; further details on the external events PRA models, their results, and the potential for additional SAMAs

based on these results; further support for the screening of certain SAMA candidates; and additional information regarding several specific SAMAs. The licensee's responses addressed the NRC staff's concerns and resulted in the identification of one

Two distinct analyses are combined additional potentially cost-beneficial SAMA.

F.2. Estimate of Risk for Duane Arnold Energy Center

FPL-DA's estimates of offsite risk at DAEC are summarized in Section G 2.1. The summary is followed by the NRC staff's review of FPL-DA's risk estimates in Section G 2.2.

FPL Energy Duane Arnold, LLC's Risk Estimates to form the basis for the risk estimates used in the SAMA analysis: (1) the DAEC Level 1 and 2 PRA model, which is an updated version of the IPE (IELP, 1992), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent DAEC Level 1 and Level 2 PRA models available at the time of the ER, referred to as the DAEC PRA (Revision 5C, July 2007 model). While FPL-DA states that the scope of the current DAEC Level 1 PRA includes external (fire and seismic) events, the SAMA analysis did not explicitly include the external events models for identifying SAMAs or evaluating the benefit of SAMAs. FPL-DA stated that fire and seismic models were not explicitly included in determining the benefit of a SAMA because Level 2 models were not available for external events; thus risk impacts could not be determined for these events (NextEra, 2009a).

The baseline CDF for the purpose of the SAMA evaluation is approximately 1.08×10^{-5} per year. The CDF is based on the risk assessment for internally initiated events. FPL-DA did not explicitly include the contribution from external events within the DAEC risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 1.57. This is discussed further in Sections G 2.2 and G 6.2.

The breakdown of CDF by initiating event is provided in Table G-1. As shown in this table, events initiated by loss of offsite power and other transients (turbine trip, main steam isolation valve (MSIV) closure and inadvertent open relief valve) are the dominant contributors to the CDF. Although not reported separately, station blackout (SBO) sequences account for 34 percent of the CDF, and anticipated transient without scram (ATWS) sequences account for 29 percent of the CDF. Internal floods contribute less than 1 percent of the CDF (NextEra, 2009a).

Table F-1. Duane Arnold Energy Center Core Damage Frequency for Internal Events

Initiating Event	CDF[a] (per year)	Percent Contribution to CDF
Loss of Offsite Power	4.0 × 10–6	37
Turbine Trip with Bypass	1.6 × 10–6	15
MSIV Closure	1.4 × 10–6	13
Inadvertent Open Relief Valve	1.2 × 10–6	11
Loss of Condenser Vacuum	5.9 × 10–7	6
Div 2 125 Volt DC Bus Failure	3.2 × 10–7	3
Manual shutdown	2.8 × 10–7	3
Loss of River Water Supply	2.8 × 10–7	3
Small loss of coolant accident (LOCA)	2.7 × 10–7	3
Loss of Feedwater	2.5 × 10–7	2
Medium LOCA	1.9 × 10–7	2
Div 1 125 Volt DC Bus Failure	1.3 × 10–7	1
Others (less than 1 percent each)	2.8 × 10–7	3
Total CDF (internal events)[b]	1.08 × 10–5	100

[a] Based on percent contribution from ER (NextEra, 2009a) and total CDF
[b] Column totals may be different due to round off

The Level 2 DAEC PRA model that forms the basis for the SAMA evaluation is essentially the original IPE Level 2 model applied to the revised Level 1 model. The Level 2 model utilizes three containment event trees (CETs) containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into accident classes which provide the interface between the Level 1 and Level 2 CET analysis. The CETs are linked directly to the Level 1 event trees and CET nodes are evaluated using supporting fault trees.

The result of the Level 2 PRA is a set of 12 release categories, also referred to as source term categories (STCs), with their respective frequency and release characteristics. The results of this analysis for DAEC are provided in Table 3.4.3-2 of Appendix F to the ER (FPL-DA, 2008). The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for each of the 12 release categories using the results of Modular Accident Analysis Program (MAAP 3.0B) computer code calculations.

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and general public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within a 50-mile radius) for the year 2040, emergency response evacuation modeling, and economic data. The core radionuclide inventory corresponds to the end-of-cycle values for DAEC accounting for the 2007 plant power upgrade to 1,912 (megawatt-thermal (MWt) and reflects the expected fuel management and burnup during the license renewal period (NextEra, 2009a). The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997a).

In the ER, FPL-DA estimated the dose to the population within 50-miles (80-km) of the DAEC site to be approximately 19.8 person-roentgen equivalent man (rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table G-2. Containment failures within the early time frame (0 to less than 6 hours following event initiation) dominate the population dose risk at DAEC.

Table G-2. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem[a] Per Year)	Percent Contribution
Early Releases (< 6 hrs)	14.1	71
Intermediate Releases (6 to <24 hrs)	4.2	21
Late Releases (≥ 24 hrs)	1.5	8
Total	**19.8**	**100**

[a]One person-rem = 0.01 person-sievert (Sv)

F.2.1. Review of FPL Energy Duane Arnold, LLC's Risk Estimates

FPL-DA's determination of offsite risk at DAEC is based on the following three major elements of analysis:

- Level 1 and 2 risk models that form the bases for the 1992 IPE submittal (IELP,1992), and the external event analyses of the 1996 IPEEE submittal (IES, 1995a)
- Major modifications to the IPE model that have been incorporated in the DAEC PRA
- MACCS2 analyses to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures

Each of these analyses was reviewed to determine the acceptability of FPL-DA's risk estimates for the SAMA analysis, as summarized below.

The NRC staff's review of the DAEC IPE is described in an NRC report dated November 12, 1996 (NRC, 1996). Based on a review of the original IPE submittal, responses to RAIs, and a revised IPE submittal, the NRC staff concluded that the IPE submittal met the intent of GL 88-20 (NRC, 1988); that is, the licensee's IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities.

No vulnerabilities or specific improvements to either hardware or procedures identified as a result of the original IPE submittal (IELP, 1992) or in the response to IPE RAIs (IES, 1995b) were deemed to be necessary. However, the licensee identified a number of potential improvements and evaluations in conjunction with the original IPE process. Specific improvements or evaluations identified were to:

- Develop an Abnormal Operating Procedure or Emergency Operating Procedure (EOP) to address total loss of 125 VDC.
- Evaluate the existing EOP guidance to terminate vessel injection from outside containment if drywell pressure exceeds 53 psia.
- Maintain heightened awareness regarding timely use of standby liquid control for ATWS.
- Test diesel fire pump capability for vessel injection and evaluate DC reserve needed to accomplish this.
- Evaluate appropriateness of terminating water injection to containment under any circumstances for which core degradation may be aggravated.
- Evaluate the use of drywell sprays as a means to control drywell temperature to avoid premature containment failure.
- Provide guidance to operators related to protection of containment and cooling debris using methods that do not require venting.
- Prioritize injection systems for use in degraded core conditions.
- Evaluate the benefits of resetting the Automatic Depressurization System (ADS) timer instead of immediately locking out the automatic initiation of ADS.

The first seven of these improvements were included in the list of Phase I SAMAs evaluated. In response to an RAI, FPL-DA discussed the resolution of the two remaining items. With regard to the prioritizing injection systems, FPL-DA indicates that it has implemented Severe Accident Guidelines based on the boiling water reactor owner's group (BWROG) strategies for degraded core conditions that include prioritization of injection sources. With regard to the potential benefit of not locking out the ADS, FPL-DA indicates that this has been reviewed as part of the boiling water reactor (BWR) industry's Emergency Operating Procedure and Severe Accident Guideline

(EOP/SAG) activities and has been concluded that the undesirable impacts of automatic ADS initiation outweighs the benefit of not locking out the ADS (NextEra, 2009a).

The original IPE took credit for a hardened containment vent to be installed shortly after IPE submittal. In addition, two improvements were identified during the revision of the original IPE that would significantly reduce the potential for flood-related accidents in the control building. These modifications to change the control building fire protection system from a “wet” pipe system to a “dry” pipe system were completed and credited in the revised IPE.

The CDF value from the 1992 IPE (7.8×10^{-6} per year) is near the middle of the range of the CDF values reported in the IPEs for other BWR 3/4 plants while the value from the 1995 update (3.3×10^{-5} per year) is in the upper third of the values reported for other BWR 3/4 plants. Figure 11.2 of NUREG-1560 shows that the IPE-based total internal events CDF for BWR 3/4 plants ranges from 9×10^{-8} per year to 8×10^{-5} per year, with an average CDF for the group of 2×10^{-5} per year (NRC 1997b). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The current internal events CDF results for DAEC are comparable to that for other plants of similar vintage and characteristics.

There have been seven revisions to the IPE model since the 1992 IPE submittal. A listing of the major changes made to the DAEC PRA since the original IPE submittal was provided in the ER (FPL-DA, 2008) and in response to an RAI (NextEra, 2009a) and is summarized in Table G-3.

While a comparison of internal events CDF between the 1992 IPE and the current PRA model indicates an increase of about 40 percent in the total CDF (from 7.8×10^{-6} per year to 1.1×10^{-5} per year), the CDF from the current PRA is about 33 percent of that from the revised IPE (from 3.3×10^{-5} per year to 1.1×10^{-5} per year).

Table G-3. Duane Arnold Energy Center Probabilistic Risk Assessment Historical Summary

Version	Description/changes from previous model	CDF (per year)
IPE 1992	Original IPE	7.8 x 10-6
3 (3A) 3/1995	Revised IPE - Revision of HPCI/RCIC battery life estimates - Re-evaluation of LOOP initiating event frequency - Addition of sole dependence of DC power on 125 VDC battery (chargers excluded) for L OOP and LOCA - Incorporation of revised control building HVAC assessment - Inclusion of control building flood	3.3 x 10-5
3B 1/1996	- Incorporation of design modification that eliminated control building flood scenario from ruptured fire water propagating to essential switchgear room Model reviewed by BWROG	1.5 x 10-5
4 (4A) 3/1998	- Relaxation of essential switchgear room's ventilation requirements - Addition of dependency of HPCI/RCIC on decay heat removal for small LOCAs - Addition of credit for river water supply recovery - LOOP sequences with SORV transferred to IORV event tree rather than to the MSIV closure event tree - Addition of credit for drywell venting - Revision of human error probability for containment heat removal models - Addition of credit for total loss of 125 VDC procedure - Updated initiating event frequencies for transients and manual shutdown - Inclusion of well water system design modification - Inclusion of common cause failure of SRVs - Incorporation of updated maintenance unavailabilities from maintenance rule database - Incorporation of explicit models for important transformers, breakers, and power source lines	1.1 x 10-5
4B 12/2001	- Conversion from REBECA to CAFTA	1.2 x 10-5
5 (5A)	- Incorporation of updated human error probabilities as result of power uprate - Incorporation of updated LOOP frequency based on operating experience - Incorporation of instrument air fault tree model as result of BWROG certification comment - Incorporation of plant-specific equipment performance data for major equipment	1.0 x 10-5
5B 2/2005	- Addition of energy service reactor/residual heat removal service water (ESW/RHRSW) pump house ventilation dependency - Addition of explicit model for recirculation pump trip failure - Incorporation of updated LOOP frequency based on SBO analysis	1.1 x 10-5
5C 7/2007	- Correction of quantification flag settings	1.1 x 10-5

The NRC staff questioned the licensee regarding the reasons for the relatively large contribution to CDF from ATWS and SBO events. In responses to RAIs (NextEra 2009a, 2009b) the licensee attributed the ATWS frequency to a relatively high ratio of power to suppression pool volume that leads to a shorter time available to initiate boron injection, and attributed the SBO frequency to DAEC being a single unit site and thus not having the additional AC power resources that would be available if another unit were at the site.

The NRC staff considered the peer reviews completed for the DAEC PRA, and the potential impact of the review findings on the SAMA evaluation. In the ER (FPL-DA, 2008) and in response to an NRC staff RAI (NextEra 2009a, 2009b), FPL-DA described the BWROG Peer Review of Revision 3B conducted in March 1997, as well as a PRA program self-assessment studied in 2004.

The BWROG review concluded "the DAEC PRA certification resulted in a very consistent evaluation across all the elements. For each element, the certification team assigned a summary grade level of 3 which supports risk significance determinations supplemented by appropriate deterministic analyses." FPL-DA identified all Level A and B (extremely important and important, respectively) facts and observations from the BWROG Peer Review and their disposition in the ER. All appear to have been satisfactorily resolved.

The 2004 self-assessment of the PRA program was analyzed by a team that included individuals from one neighboring PWR and one neighboring BWR with a primary focus on ensuring that the DAEC PRA program complies with applicable standards and to identify potential program enhancement opportunities. The assessment team concluded that, in general, the DAEC had established, implanted, and maintained a PRA program consistent with applicable fleet (at that time Nuclear Management Company) standards.

In response to an RAI, FPL-DA described the PRA update process in use at DAEC. Department instructions define the overall quality assurance control responsibilities, authorities, and requirements, as well as provide guidance on the maintenance, revision and configuration management of the model, and associated documentation and software. PRA model changes and associated documentation are reviewed by qualified individuals within FPL-DA's corporate PRA department which includes DAEC PRA personnel. If appropriate, changes and associated documentation are also reviewed by site System Engineering, Training or Operations personnel. Completed documents are approved by either site or corporate supervisory personnel responsible for PRA activities.

FPL-DA states that the Revision 5 PRA incorporates all plant modifications completed up to approximately 1999 and that a review of modification packages initiated since late 1997 was performed to assess their potential impact on the SAMA analysis. It was determined that no completed modifications would have a non-conservative impact on the SAMA results.

Given that the DAEC internal events PRA model has been peer-reviewed and the peer review findings were all addressed, and that FPL-DA has satisfactorily addressed NRC staff questions regarding the PRA, the NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

As indicated above, FPL-DA maintains a current DAEC external events PRA that explicitly models seismic and fire initiated core damage accidents. The models are stated to be based on the original DAEC IPEEE. Both the original IPEEE and current models are described in the ER.

The DAEC IPEEE was submitted in November 1995 (IES, 1995a), in response to Supplement 4 of Generic Letter 88-20 (NRC, 1991b). This analysis included a seismic margins analysis, a fire screening analysis, and a screening analysis for other external events. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified, a list of improvement opportunities was developed as discussed below. In a letter dated March 10, 2000, the NRC staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC, 2000).

The DAEC IPEEE seismic analysis utilized a seismic margin assessment (SMA) approach following NRC guidance (NRC, 1991a) and Electric Power Research Institute (EPRI) guidance (EPRI, 1991). This method is qualitative and does not provide numerical estimates of the CDF contributions from seismic initiators. The seismic analysis was completed in conjunction with the Seismic Qualification User Group (SQUG) program (SQUG, 1992). The review level earthquake (RLE) was taken to be the safe shutdown earthquake (SSE).

Approximately 850 items identified for the safe shutdown equipment list (SSEL) were evaluated using the four screening considerations in the SQUG Generic Implementation Procedure, i.e., seismic capacity versus demand, equipment class caveats, equipment anchorage, and seismic interactions. Exceptions were shown to be acceptable by calculation or were resolved by modification or maintenance action (NRC, 2000). For structures, one masonry wall was identified as an outlier and was subsequently qualified for SSE loadings, and inspection of the control room ceiling indicated potential outliers that were resolved by selected modifications. Several seismic-induced fire and flood outliers were noted including unanchored gas storage bottles, air-handlers in the HPCI room and inadequate supports for the turbine lube oil storage tank. The first was resolved by providing restraints or removing the bottles, the second shown by analysis to have adequate clearance, while the latter was shown not to be risk significant (CDF less than 1×10^{-6} per year) (NRC 2000, 2002). The NRC review and closeout of USI A-46 for DAEC is documented in a letter dated July 29, 1998 (NRC, 1998).

While the DAEC individual plant examination of external events (IPEEE) did not identify any vulnerabilities due to seismic events, potential improvements and strategies were discussed. These improvements involved the resolution of the outliers identified during the IPEEE process. While all were indicated to have been completed in the IPEEE submittal, they were incorporated in the Phase I SAMA list for completeness. This is discussed further in Section G3.

Subsequent to the IPEEE, the licensee created a seismic PRA. The DAEC seismic PRA utilizes the 1994 seismic hazard curves from Lawrence Livermore National Laboratory (NRC, 1994). The seismic CDF model credits only the equipment in the SSEL developed for the IPEEE. Fragilities of the equipment were obtained from high confidence low probability of failure (HCLPF) values from industry studies. The probability of failure due to earthquake motion was then combined with random failures in modified versions of system fault trees. The Revision 5C seismic CDF is 7.0×10^{-7} per year. In response to an RAI, FPL-DA provided additional information on the seismic PRA including the SSEL systems and equipment of interest, the issues included in the seismic event trees, the treatment of fragility dependencies, human errors employed, and the treatment of the turbine lube oil tank issue. FPL-DA also identified conservatisms and non-conservatisms in the analysis (NextEra, 2009a). Based on the information provided, the staff concludes that while the above seismic CDF value may be appropriate for DAEC, the best estimate seismic CDF value might also be higher than that given above due to the lack of DAEC-specific fragilities, the treatment of fragility dependencies, and the lack of consideration of increases in human error rates for seismic-initiated events.

To provide additional insight as to the appropriate seismic CDF to use for the SAMA evaluation, the NRC staff developed an independent estimate of seismic CDF for DAEC using the simplified hybrid method described in a paper by Robert P. Kennedy, entitled “Overview of Methods for Seismic PRA and Margin Analysis Including Recent Innovations” (Kennedy, 1999) and using the 1994 LLNL hazard curve from NUREG-1488. This approach uses a median capacity (C_{50}) of 0.30g (based on the DAEC IPEEE of high confidence low probability of failure screening value for critical equipment) to represent the overall plant fragility. The NRC staff’s independent calculation conservatively estimates the seismic CDF for DAEC to be approximately 1×10^{-5} per year. This value is an order of magnitude greater than that given by FPL-DA in the ER.

Based on the above, the NRC staff requested the licensee to assess the impact that a higher seismic CDF would have on the results of the SAMA analysis. This is discussed further in Section G 6.2.

The NRC staff inquired about the important contributors to seismic risk. In response to an RAI, FPL-DA provided a listing and description of the seismic core damage sequences with a CDF of 1×10^{-8} per year or more (NextEra 2009a, 2009b). The dominant seismic core damage sequences are listed in Table G-4.

Table G-4. Dominant Contributors to Seismic Core Damage Frequency

Seismic Sequence Description	CDF per year
A seismic event with a magnitude of 1.0 g or more causes wide-spread failure of safe-shutdown equipment. Core damage occurs due to loss of injection in a potentially damaged containment.	1.5 × 10–7
A seismic event with a magnitude between 0.7 and 0.9 g results in loss of off site power and failure to scram. HPCI and RCIC are conservatively not credited leading to core damage at high RPV pressure.	5.0 × 10–8
A seismic event with a magnitude between 0.7 and 0.9 g results in loss of off site power with a successful scram. HPCI and RCIC are conservatively not credited leading to the requirement for depressurization. This fails resulting in core damage at high RPV pressure.	4.6 × 10–8
A seismic event with a magnitude between 0.7 and 0.9 g causes wide-spread failure of safe-shutdown equipment. Core damage occurs due to loss of injection in a potentially damaged containment.	4.1 × 10–8
A seismic event with a magnitude between 0.9 and 1.0 g causes wide-spread failure of safe-shutdown equipment. Core damage occurs due to loss of injection in a potentially damaged containment	3.8 × 10–8
A seismic event with a magnitude between 0.7 and 0.9 g results in loss of off site power with a successful scram. HPCI and RCIC are conservatively not credited leading to the requirement for depressurization. Depressurization and low pressure injection is successful but long term containment heat removal fails resulting in core damage at high containment pressure.	3.3 × 10–8
A seismic event with a magnitude between 0.7 and 0.9 g results in loss of off site power with a successful scram. HPCI and RCIC are conservatively not credited leading to the requirement for depressurization. Depressurization is successful but low pressure injection fails leading to core damage.	3.2 × 10–8
A seismic event with a magnitude between 0.7 and 0.9g results in loss of offsite power with a successful scram. HPCI and RCIC are conservatively not credited leading to the requirement for depressurization. Depressurization is successful but low pressure injection fails leading to core damage.	3.2 × 10–8
Others	3.2 × 10–7
Total (all seismic sequences)	7.0 × 10–7

The DAEC IPEEE fire analysis employed EPRI's fire-induced vulnerability evaluation (FIVE) method to analyze a qualitative screening and then a progressive probabilistic evaluation that considers the sequence of events that must occur to prevent safe shutdown. This evaluation considered fire propagation, damage, and suppression effectiveness if required. An area was screened out from further analysis once the fire induced core damage frequency dropped below 1×10^{-6} per year. A walkdown and verification process was employed to determine weather or not the assumptions and calculations were supported by the physical condition of the plant.

Two fire compartments remained unscreened at the end of the quantification process, Divisions I and II 4kV essential switchgear rooms. The fire induced CDF for these two rooms was 5.6×10^{-6} and 4.9×10^{-6} per year, respectively, for a total fire CDF of approximately 1×10^{-5} per year. FPL-DA stated that these values are conservative since fire brigade and offsite fire fighting are not credited.

While no vulnerabilities were identified in the DAEC IPEEE due to fire events, potential improvements and strategies were identified and discussed in the IPEEE. These improvements were: prohibiting work in the switchgear room supporting the operating river water train during river water system maintenance, posting a fire watch in the switchgear room supporting the operating river water train during river water system maintenance, and converting the two fire protection pipes in the heating, ventilation, air conditioning (HVAC) control building from a "wet" pipe system to a "dry pipe" system. In addition, the NRC staff SER for the DAEC IPEEE indicates that cables for Division II equipment required for the remote shutdown of the plant were being rerouted so that they do not pass through the cable spreading room and that implementation of this modification was nearing completion at the time of the IPEEE submittal. In response to an RAI FPL-DA confirmed that this rerouting had been completed. These improvements, except for the cable rerouting, were incorporated in the Phase I SAMA list for completeness. This is discussed further in Section G.3.

Subsequent to the IPEEE, the licensee created a fire PRA. The Revision 5C fire CDF is 3.0 x 10-6 per year. In response to an RAI, FPL-DA provided further information on the fire PRA. The modeling in the fire PRA consists of three main steps: (1) determining the fire frequency for each compartment, (2) analyzing fire growth, and (3) suppression analysis and determining the fire induced CDF. The DAEC fire PRA utilizes the compartment fire ignition frequencies from the DAEC IPEEE. Fire growth and suppression event trees were developed based on the FIVE method as implemented in the IPEEE. The end points of the fire growth and suppression event trees are four fire damage states. Core damage frequency was then determined using a fire induced core damage event tree for each fire damaged state in each compartment. Fire compartments that had core damage frequencies of 2.5× 10-8 per year or more in the IPEEE analyses were analyzed further in the fire PRA.

In response to an RAI, FPL-DA provided a listing of the fire initiator contribution to the total fire CDF as indicated by the fire PRA. The dominant contributors are listed in Table G-5.

Table G-5. Important Fire Areas and Their Contributions to Fire Core Damage Frequency

Fire Area Description	CDF (per year)
Essential Switchgear Room Division I	8.5 × 10–7
Lower Non-essential Switchgear Room	7.8 × 10–7
Essential Switchgear Room Division II	3.4 × 10–7
Control Room Complex	2.0 × 10–7
Reactor Building, Third Floor	1.2 × 10–7
Battery Room, Division II	1.2 × 10–7
Reactor Building, Second Floor	1.2 × 10–7
Other	4.7 x 10-7
Total (all fire areas)	3.0 x 10-6

The licensee also identified a number of conservatisms and non-conservatisms in the fire PRA model (FPL-DA 2008; NextEra 2009a, 2009b). The conservatisms identified are:

- The assumption that a reactor trip (either automatic or manual) will be generated for all fires inside the security fence
- The susceptibility to failure of unprotected cables entering and exiting the metal-enclosed components even for low-intensity fires
- The assumption that internal cabinet fires disable the entire MCC or cabinet
- Fire suppression or the fire brigade is not credited (See clarification below)
- ATWS mitigation features (SLC, manual rod insertion, level/power control, etc.) are not credited
- Neither Thermo-Lag nor other fire wraps are credited
- The assumption that systems for which cabling has not been tracked and located are disabled for all fires

Potential non-conservatisms identified are:

- MCC and other metal-enclosed components are not considered susceptible to failure by exposure to low-intensity external fires
- Primary containment is not analyzed due to the inert atmosphere
- The assumption that the electrical portions of the reactor scram function fails safe
- Fire barriers will contain fires up to their listed ratings

In response to an RAI, FPL-DA clarified that while neither fire suppression nor the fire brigade is credited if the core damage frequency for the compartment under consideration is 1×10^{-7} per year or less, they are credited if the initial value exceeds this criteria. The improved realism provided by the fire growth and suppression event trees resulted in a reduction in CDF for the Divisions I and II 4KV essential switchgear rooms from the relatively high IPEEE values.

It is noted that the IPEEE and the current PRA screened out the cable spreading room on the basis of the absence of no fixed fire sources in the room. A screening value for the cable spreading room of 2.3×10^{-7} per year was provided in the IPEEE and no CDF for the cable spreading room was evaluated in the current fire PRA. The lack of a quantified CDF for the cable spreading room at DAEC is in contrast with the results of a number of similar BWR 3/4 plants. While the lack of a cable spreading room is of concern, the value is not expected to significantly change the fire CDF.

Considering the above discussion, the conservatisms and non-conservatisms and the response to the staff RAIs, the staff concludes that the fire CDF of 3.0×10^{-6} per year is reasonable for the SAMA analysis.

The IPEEE analysis of high winds and tornadoes estimated there contribution to CDF to be 1.4×10^{-7} per year. The NRC staff review of the analysis noted some weaknesses in the analysis; nevertheless, the staff concluded that nevertheless the CDF from high winds at DAEC is on the order of 1×10^{-6} per year and would not constitute a vulnerability (NRC, 2000). For external floods, the IPEEE concluded that DAEC meets the 1975 Standard Review Plan and therefore no further analysis was needed. For transportation and nearby facility hazards, the IPEEE concluded that no floods posed a threat to the plant.

While no vulnerabilities to high winds, floods, and other external events were identified in the DAEC IPEEE, potential improvements and strategies were identified and discussed in the IPEEE. These improvements were: increasing the distance between a new on-site hydrogen storage tank and safety-related structures, and constructing barriers around the auxiliary boiler propane storage tank. These improvements were incorporated in the Phase I SAMA list and all have been implemented. This is discussed further in Section G 3.

As indicated in Supplement 1 to the License Renewal application (FPL-DA, 2009), a multiplier of 1.57 was used to adjust the internal event risk benefit associated with a SAMA to account for external events. In response to an RAI, FPL-DA indicated that this multiplier was based on a total external event CDF of 6.2 x 10^{-6} per year. This CDF is the sum of the total fire and seismic CDF from the DAEC external events PRA (3.74 x 10^{-6} per year rounded up to 4 x 10^{-6} per year) plus the high wind and tornado CDF from the IPEEE (1.4 x 10^{-7} per year rounded up to 2 x 10^{-7} per year) plus the screening values for external flooding and transportation events (1 x 10^{-6} per year for each). The external event CDF is thus 56.4 percent of the internal events CDF (1.08 x 10^{-6} per year rounded up to 1.1 x 10^{-6} per year). Thus, the total CDF is 1.564 times the internal events CDF and this was rounded up to 1.57 (NextEra, 2009a).

As indicated above, the NRC staff estimates that the seismic CDF might be as high as approximately 1 x 10^{-5} per year. If this is combined with a fire CDF of 3 x 10^{-6} per year, and if the other contributions to external events CDF are negligible by comparison, the total multiplier to account for external events might be as high as 2.3. In response to an RAI, FPL-DA addressed the impact of using this higher multiplier on the results of the SAMA assessment. This is discussed further in Section G 6.2.

The NRC staff reviewed the general process used by FPL-DA to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to NRC staff requests for additional information (FPL-DA 2008; NextEra 2009a, 2009b). The current Level 2 model utilizes a set of CETs containing both phenomenological and systemic events. The Level 1 core damage sequences are grouped into core damage accident classes with similar characteristics. All of the sequences in an accident class are then input to a CET by linking the level 1 event tree sequences with the level 2 CET. The CETs are analyzed by the linking of fault trees that represent each CET node. Whenever possible the fault trees utilized in the Level 1 analysis are utilized in the CETs to propagate dependencies.

Each CET end state represents a radionuclide release to the environment. Each is assigned to an STC based on magnitude and timing of release. Twelve release categories, as defined in the IPE, are utilized. Magnitude is given by CsI release fraction: High (H) > 10 percent, Moderate (M) 1 to 10 percent, Low (L) 0.1 to 1 percent and Low-Low (LL) <0.1 percent. Timing is based on the time of initial release relative to the time of accident initiation (scram): Early (E) < 6 hours, Intermediate (I), 6 to 24 hours and Late (L) > 24 hours. The assignment to release magnitude bins was done by consideration of three fundamental variables, initial containment failure mode, water availability and reactor building effectiveness (NextEra 2009a, 2009b).

The frequency of each STC was obtained by adding the frequencies of the contributing CET end states. The release characteristics for each STC were developed by using the results of MAAP 3.0B computer code calculations. The MAAP cases which represented the largest release fractions of those in an STC were used to characterize the entire STC. The STCs, their frequencies, and release characteristics are presented in Tables 3.4.3-2 and 3.4.4-1 of Appendix F to the ER (FPL-DA, 2008).

The NRC staff review of this information noted a number of apparent discrepancies in the STC assignments with respect to timing and release magnitude and requested the licensee to clarify the reasons for these discrepancies (NRC 2009a, 2009b). As indicated above, the timing of release was measured relative to the time of accident initiation rather than the time of declaration of general emergency. This results in assigning sequences to a “Late” bin when they would be “early”, considering the time of emergency declaration given in the ER. However, the Level 3 consequence analysis correctly used the period between the time of emergency declaration and the time of release in evaluating the effectiveness of the evacuation, and a sensitivity study showed that the population dose and the off-site economic cost results are not sensitive to the time used. Thus, this inconsistency in treating release timing would not significantly impact the SAMA analysis.

With regard to release magnitude, the staff noted that the release fractions for a number of STCs did not agree with the above definitions. In most cases the release fractions utilized were greater than that prescribed by the STC definition. This apparently was the result of the process for assigning sequences to the STCs, and selecting the highest release fraction of the assigned sequences to represent the STC. In one case, STC M/I (moderate release magnitude and intermediate release timing), the release fraction utilized did not include the scrubbing from the suppression pool. This was due to the fact that pool scrubbing was not included in the Level 2 MAAP analysis but was added manually. The release fraction used in the Level 3 analysis also excluded this correction. In response to an RAI, the licensee indicated that use of the correct release fraction (a factor of 10 lower) would reduce the total population dose by about 8 percent.

The DAEC Level 2 PRA model is essentially that used in the IPE. As indicated in the ER, no changes to major modeling assumptions, containment event trees structure, accident progression/source term calculations, or binning of end states in the Level 2 PRA model have been made since the IPE submittal. The NRC staff’s review of the IPE Level 2 model concluded that it appeared to have addressed the severe accident phenomena normally associated with the Mark I containment type, that it met the IPE requirements, and that there were no weaknesses. It was noted, however, that DAEC appears not to have analyzed a thorough internal peer review of the back-end (i.e. Level 2) portion of the IPE. The BWROG review did not have any important (i.e., Level A or B) facts and observations from its review of the Level 2 model.

Since there have been no major changes in the Level 2 PRA since the IPE and the IPE Level 2 model was based on the state of knowledge in the 1991–1992 time frame, the staff asked FPL-DA to discuss the impact of the current state of knowledge on key BWR accident and containment failure phenomenology on the Level 2 assumptions and results used for the SAMA analysis. FPL-DA responded that while the Level 2 analysis was updated to reflect the current Level 1 model, there have been no major changes in the state of knowledge regarding accident progression and containment failure mechanisms that would require a change in the Level 2 model. FPL-DA indicated that a peer assessment analyzed in 2007, subsequent to the preparation of the ER, concluded that the DAEC Level 2 analysis is comprehensive and acceptable for risk-informed applications such as SAMA, that the model can still be considered state of the art, and that the sequence binning and release characterization met the American Society of Mechanical Engineers (ASME) Code Standard. The reviewers suggested that FPL-DA upgrade from MAAP 3.0B to MAAP 4. FPL-DA has not yet implemented this change. The staff concludes that, given the conservative release fractions used for the important STCs, upgrading the MAAP analysis will not adversely impact the SAMA evaluation.

Based on the NRC staff's review of the Level 2 method, the licensee's responses to RAIs and the fact that the Level 2 model was reviewed in more detail as part of the BWROG peer review' plus a more recent review for conformance to the ASME Code PRA standard was found acceptable, the NRC staff concludes that the Level 2 PRA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

FPL-DA used the MACCS2 code and a core inventory from a plant specific ORIGEN2 calculation to determine the offsite consequences of activity release (NextEra, 2009b). FPL-DA confirmed that the inventory used reflects the expected fuel management/burnup during the license renewal period (NextEra, 2009a).

The NRC staff reviewed the process used by FPL-DA to extend the containment analysis (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was used to estimate offsite consequences. Plant-specific input to the code includes the source terms for each source term category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within a 50-mile (80-km) radius for the year 2040, emergency evacuation modeling, and economic data. This information is provided in Section 3.4 of Appendix F to the ER (FPL-DA, 2008).

All releases were modeled as being from the off-gas stack or the top of the reactor building depending on the accident sequence release location. In response to an RAI, FPL-DA indicated the type of sequence released from each location. The results of sensitivity studies on release height or location provided in the original submittal and in response to an RAI indicated a negligible impact (less than plus or minus 3 percent) on both population dose and offsite economic cost. The thermal content of each of the releases was assumed to be the same as ambient (that is a non-buoyant plume). Wake affects for the 140-foot high and 140-foot wide reactor building were included in the model. Sensitivity studies were analyzed on these assumptions and indicated little (approximately 1 percent increase or decrease) or no change in population dose or offsite economic cost. Another sensitivity study showed that removing the base case assumption of perpetual rainfall in the 40–50 mile segment surrounding the site would result in a 9 percent reduction in population dose and a 15 percent reduction in offsite costs. Based on the information provided, the staff concludes that the release parameters used are acceptable for the purposes of the SAMA evaluation.

FPL-DA used site-specific meteorological data for the 2005 calendar year as input to the MACCS2 code. The development of the meteorological data is discussed in Section 3.4.5 of Appendix F to the ER and in response to an RAI (NextEra, 2009a). The data were collected from the onsite meteorological monitoring system. Sensitivity analyses using MACCS2 and the meteorological data for the years 2002 through 2006 show that use of data for the year 2005 results in the largest dose and economic cost risk. Missing meteorological data was filled using data: from another level on the met tower (accounting for the relationship between the levels as determined from the preceding hours); by interpolation if the gap were less than 4 hours; or from the hour and a nearby day of a previous year. Missing precipitation data was obtained from a nearby airport. The NRC staff notes that previous SAMA analyses results have shown little sensitivity to year-to-year differences in meteorological data and concludes that the use of the 2005 meteorological data in the SAMA analysis is reasonable.

The population distribution that the licensee used as input to the MACCS2 analysis was estimated for the year 2040 using year 2000 census data as accessed by SECPOP 2000 (NRC, 2003) as a starting point. The 2000 population was adjusted to account for transient population obtained from the evacuation time estimate study (TOMCOD, 2003). County growth rates based on projections from State Data Center of Iowa (State Library, 2006) were applied to obtain the distribution in 2040. These data were used to project county-level resident and transient populations to the year 2040 using an exponential fit and applied to each zone based on the fraction of each county within the zone. The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 kilometers (10 miles) from the plant (the emergency planning zone (EPZ). FPL-DA assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC, 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone. The evacuated population was assumed to move at an average radial speed of approximately 4.4 miles per hour (2.0 meters per second) with a delayed start time of 17 minutes after declaration of a general emergency. A general emergency declaration was assumed to occur at the onset of core damage. The evacuation speed (0.314 meters per second) was derived from the projected time to evacuate the entire EPZ under winter, weekday, mid-day, adverse weather conditions during the year 2000 (TOMCOD, 2003) and then adjusted by the ratio of the year 2000 EPZ population to the projected year 2040 EPZ population. Sensitivity studies on these assumptions indicate that there is little or no change to the population dose or offsite economic cost by the assumed variations. The sensitivity studies included setting the general emergency declaration time to zero (the earliest possible declaration time). This change resulted in a 2 percent reduction in population dose and no change in offsite economic cost. The NRC staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Site-specific agriculture and economic data was provided from SECPOP 2000 (NRC, 2003) by specifying the data for each of the counties surrounding the plant to a distance of 50 miles (80 km). This included the fraction of land devoted to farming, annual farm sales, the fraction of farm sales resulting from dairy production, and the value of non-farm land. SECPOP2000 utilizes economic data from the 1997 National Census of Agriculture (USDA, 1998). In response to an RAI, FPL-DA analyzed a sensitivity study which indicated that replacing the data from the 1997 National Census of Agriculture with data from the 2002 National Census of Agriculture (USDA, 2002) has a negligible (less than 1 percent) impact on results (NextEra, 2009a).

Area wide farm wealth was determined from 2002 National Census of Agriculture (USDA, 2002) county statistics for farmland, buildings and machinery, with only the fraction of each county within 50 miles of DAEC considered. Non-farm wealth was taken as the population-weighted average of the SECPOP2000 non-farm property value. In addition, generic economic data that applied to the region as a whole were revised from the MACCS2 sample problem input in order to account for cost escalation since 1986 (the year the input was first specified). This included parameters describing cost of evacuating and relocating people, land decontamination and property condemnation. An escalation factor of 1.90 was applied to these parameters to account for cost escalation from 1986 (the year the input was first specified) to July 2007.

FPL-DA confirmed that the three recently discovered problems in SECPOP2000 have all been accounted for in preparing the input for DAEC (NextEra, 2009a). These problems involved: (1) an inconsistency in the format in which several economic parameters were output from the SECPOP2000 code and input to the MACCS2 code, (2) an error that resulted in use of agricultural/economic data for the wrong counties in the SECPOP2000 calculations, and (3) an error that resulted in the economic data for some counties being handled incorrectly.

The NRC staff concludes that the methods used by FPL-DA to estimate the offsite consequences for DAEC provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by FPL-DA.

F.3. Potential Plant Improvements

This section discusses the process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by FPL-DA.

F.3.1. Process for Identifying Potential Plant Improvements

FPL-DA's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- Review of the most significant basic events from the current, plant-specific Level 1 PRA,
- Review of potential plant improvements identified in the DAEC IPE and IPEEE,
- Review of generic SAMA candidates from Table 13 of NEI 05-01 (NEI 2005), and
- Review of the above generic and site-specific SAMAs by an expert panel to identify any additional candidates.

The expert panel consisted of 16 individuals with a wide range of plant, design, and analysis experience. The panel identified one additional SAMA, SAMA 156 – Provide an alternate source of water for the Residual Heat Removal/Emergency Service Water (RHR/ESW) pit.

Based on this process, an initial set of 166 candidate SAMAs, referred to as Phase I SAMAs, was identified. These are identified in Table 5.5-1 of Appendix F to the ER (FPL-DA, 2008). In response to an NRC staff RAI, FPL-DA provided further information on the potential for a modification to the lube oil storage tank support structure found in the IPEEE to fail at the DAEC safe shutdown earthquake. This modification was designated as SAMA 167 and was added to the Phase I list of SAMA candidates in an update to the ER (NextEra, 2009c).

In Phase I of the evaluation, FPL-DA analyzed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- The SAMA is not applicable at DAEC due to design differences (23 screened out).
- The SAMA has already been implemented at DAEC (104 screened out initially; 103 screened out in updated ER after correcting miss-categorization of SAMA 118).
- The SAMA is similar in nature and could be combined with another SAMA candidate (2 screened out).
- The SAMA requires excessive changes that will obviously exceed the maximum benefit (13 screened out initially; 15 screened out in updated ER after correcting miss-categorization of SAMA 118 and adding SAMA 167).
- The SAMA is related to a non-risk significant system for which changes in reliability are known to have negligible impact on risk (none screened out).

Based on this screening, a total of 143 SAMAs were eliminated leaving 24 for further evaluation. The results of the Phase I screening analysis are given in Table 6-1 of Appendix F to the ER. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table 7.1.3-1 of Appendix F to the ER. In Phase II, a detailed evaluation was analyzed for each of the 24 remaining SAMA candidates, as discussed in forthcoming Sections G 4 and G 6 below. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 1.57, as previously discussed.

F.3.2. Review of FPL Energy Duane Arnold, LLC's Process

FPL-DA's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. In response to NRC staff RAIs, explicit consideration was also given to potential SAMAs for fire and seismic events. The initial list of SAMAs generally addressed the hardware failures and human actions considered to be important to CDF from risk reduction worth (RRW) perspectives at DAEC, and included selected SAMAs from prior SAMA analyses for other plants.

FPL-DA provided a tabular listing of the dominant human action contributors (Table 5.1-1 of Appendix F to the ER) and dominant hardware contributors (Table 5.1-2 of Appendix F to the ER) to CDF sorted according to their RRW (FPL-DA, 2008). SAMAs impacting these basic events would have the greatest potential for reducing risk. FPL-DA used a RRW cutoff of 1.005, which corresponds to about a one-half percent change in CDF given 100-percent reliability of the SAMA. This equates to a benefit of approximately $11,000 (after the benefits have been multiplied to account for external events).

Initially, no Phase I SAMAs were identified for the human actions on the basis that DAEC procedures and training meet current industry standards. The NRC staff noted that the CDF contribution from failure of important operator actions could possibly be reduced by provision of additional alarms or automating the action. In response to an RAI, FPL-DA indicated that risk significant operator actions have been prioritized in operator training and scrutinized for improvement opportunities. Several improvements implemented were described. FPL-DA stated that appropriate indications and alarms are already in place and any hardware modifications to automate operator actions would typically cost substantially more than any benefit and may create the potential for adverse impacts or consequences. In conclusion, no SAMAs in this area were identified for further consideration.

The FPL-DA review of the important hardware contributors identified four new plant specific SAMAs. 15 generic SAMAs were stated to address the remaining important contributors. The NRC staff noted that the most important hardware contributor in the RRW table (event PDI1947, failure of the RHRSW Loop “B” heat exchanger differential pressure indicator, with a RRW of 1.053) is addressed by SAMA 165, to improve the differential pressure indicators. However, this SAMA was subsequently screened out on the basis that it was not applicable since the PRA did not reflect a plant modification that had been implemented at DAEC. In an RAI, the NRC staff noted that event PDI2046, involving failure of the corresponding pressure indicator in Loop “A”, has a RRW of only 1.005. In response, FPL-DA indicated that the RRW value for event PDI1947 reported in the ER was in error and that the correct value should be 1.005 (NextEra, 2009a). Since this value is at the low RRW cutoff, no SAMA is appropriate for these pressure indicators. This error was corrected in the ER update (NextEra, 2009c).

A total of 17 DAEC specific SAMAs based on improvements identified in the IPE and IPEEE were included in the Phase I list. All were screened out on the basis that they have been implemented.

Table 6-1 of the ER provides the results of Phase I screening of the initial list of SAMA candidates. The NRC staff questioned the screening out of a number of SAMAs on the basis that they were not applicable to DAEC or were already implemented at DAEC. In response to an RAI and subsequent request for clarification, FPL-DA provided additional information to support the screening of the questioned items. The additional information included: (1) results of fire studies that did not find fire barrier or spurious actuation vulnerabilities or weaknesses, (2) the identification of equipment, procedures and programs in place at DAEC that effectively implement the intent of the SAMA and/or result in most of the risk reduction that could be achieved by the SAMA, and (3) for one SAMA (SAMA 118 – add an independent boron injection system) a correction to the reported basis for screening. For SAMA 159, which originated from the IPEEE and involves either posting a fire watch in the switchgear room supporting the operating river water train, or staging temporary hoses for implementation of abnormal operation procedure (AOP)-410, Total Loss of River Water, FPL-DA concluded that the need for such a requirement has been eliminated since the emergency switchgear rooms fire risk has been reduced by a factor of ten from that in the IPEEE. The NRC staff agrees with this conclusion.

The NRC staff also questioned FPL-DA about lower cost alternatives to some of the SAMAs evaluated, including:

- Using a portable diesel driven pump for low pressure injection through existing systems,
- Using a portable diesel driven pump to provide makeup to the RHRSW/ESW pit,
- Using a portable DC power supply to maintain DC power availability for SBO sequences,
- Improving the reliability of cross-ties between the RHR system and (1) the RHR service water, (2) the fire system or (3) other systems that could be used for alternate low pressure injection, and
- Creating a procedure to maximize CRD flow to provide early and/or late injection.

In response to the RAIs, FPL-DA addressed the suggested lower cost alternatives, and indicated that all of these alternatives are effectively covered by existing procedures (NextEra, 2009a). This is discussed further in Section G 6.2.

Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER addresses the major contributors to internal event CDF.

Although the Phase I list of potential SAMAs did include candidate SAMAs for external events based on generic insights and the IPEEE results, FPL-DA did not report that the DAEC seismic and fire PRA models were systematically reviewed for the purpose of identifying potential external event SAMAs. In response to an RAI, FPL-DA provided a listing of important component and human error events for the seismic and fire initiated events sorted by risk reduction worth. FPL-DA noted that almost all of the important seismic and fire contributors were the same as those identified for internal events and reviewed for potential SAMAs. FPL-DA reviewed those events that are not on the internal events list and determined that they were either covered by existing SAMAs or, for human errors, are unlikely to be reduced by improved procedures.

The NRC staff noted that all of the important seismic and fire basic events discussed above are random failures and none are due to the effects of the seismic or fire initiating event. In response to a NRC staff RAI, FPL-DA attributed this to the manner in which seismic and fire failures are incorporated in the external events models.

In a further effort to identify external event SAMAs, the NRC staff requested FPL-DA to list the important seismic and fire initiated core damage sequences and to review them for potential SAMAs. FPL-DA provided the requested information and stated that a review of the dominant fire and seismic sequences did not identify any potential SAMAs. The major sequences are extreme magnitude earthquakes that cause widespread damage and significant fires in the essential and non-essential switchgear rooms.

The staff notes that the largest contributor to fire risk is a sequence involving a severe fire in the lower (non-essential) switchgear room that disables multiple equipment in the room and has a CDF contribution of 7.4×10^{-7} per year (NextEra, 2009a) while the largest contributor to seismic risk is a sequence involving a severe earthquake that causes widespread damage and has a CDF contribution of 1.5×10^{-7} per year (NextEra, 2009a). These sequences correspond to 7.4 percent and 1.5 percent of the internal events CDF, respectively. Eliminating them entirely would have a benefit of $110,000 and $22,000, respectively. Considering that the minimum cost of a hardware modification would likely exceed $100,000, the NRC staff concludes that it is unlikely that any SAMAs to address these fire or seismic sequences would be cost beneficial.

Failure of the turbine lube oil tank support structure leading to a fire and core damage was identified in the DAEC IPEEE (IES, 1995a) and discussed extensively in the IPEEE SER (NRC, 2000). In response to NRC staff RAIs, FPL-DA provided additional information on this failure, its modeling in the seismic PRA, and the potential for a cost beneficial SAMA to address the failure. The failure is described as a buckling of the five foot tall support structure leading to the tank tipping over, breaching the surrounding wall, and spilling oil into the turbine building causing a major fire. This is assessed to have a CDF contribution of 1×10^{-7} per year. This corresponds to approximately 1 percent of the internal events CDF. Eliminating or reducing this risk would involve adding stiffeners to the support structure. The benefit associated with eliminating this risk is given by FPL-DA as 1 percent of the maximum attainable benefit (MAB) of $2.3 million or $23,000. FPL-DA points out that since this is less than the minimum cost for a hardware fix of $100,000, strengthening the lube oil tank support structure would not be cost effective.

The NRC staff notes that since the MAB used above includes a multiplier of 1.57 to account for both internal external events, the benefit of eliminating this failure would be only $14,000 (when the benefit in internal events is not included). The staff further notes that while there is the possibility that the CDF contribution from the lube oil tank support structure is greater than the value cited above, even if the seismic contribution were increased by a decade, the modification would have to cost less than $140,000 to be cost beneficial. This is considered unlikely given the nature of the required fix and the associated analysis required. Based on the above, the NRC staff concludes that a SAMA to address the lube oil tank support structure failure need not be evaluated further.

Based on the licensee’s IPEEE, the A-46 efforts to identify and address seismic outliers, the modifications that have already been implemented, the review of the results of the DAEC seismic and fire PRAs, and the expected cost associated with further risk analysis and potential plant modifications, the NRC staff concludes that the opportunity for seismic and fire-related SAMAs has been adequately explored and that it is unlikely that there are any cost-beneficial, seismic- or fire-related SAMA candidates.

As stated earlier, other external hazards (i.e., high winds, external floods, and transportation and nearby facility accidents) are below the IPEEE threshold screening frequency and are not expected to impact the conclusions of the SAMA analysis. Two improvements were, however noted in the IPEEE and were implemented. The NRC staff concludes that the licensee's rationale for eliminating other external hazard enhancements from further consideration is reasonable.

The NRC staff notes that the set of SAMAs submitted is not all-inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated when the subsidiary costs associated with maintenance, procedures, and training are considered.

The NRC staff concludes that FPL-DA used a systematic and comprehensive process for identifying potential plant improvements for DAEC, and that the set of potential plant improvements identified by FPL-DA is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the plant-specific risk studies and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire and seismic risks and the absence of external event vulnerabilities reasonably justifies primarily examining the internal events risk results for this purpose.

F.4. Risk Reduction Potential of Plant Improvements

FPL-DA evaluated the risk-reduction potential of the 24 remaining SAMAs that were applicable to DAEC. The majority of the SAMA evaluations were analyzed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. On balance such calculations overestimate the benefit and are conservative.

FPL-DA used model re-quantification to determine the potential benefits. The CDF, population dose reductions, and offsite economic cost reductions were estimated using the DAEC PRA model. The changes made to the model to quantify the impact of SAMAs are described in Table 7.1.3-1 of Appendix F to the ER (FPL-DA, 2008). Table G-6 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table G-6 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section G 6.

The NRC staff questioned the assumptions used in evaluating the benefits or risk reduction estimates of certain SAMAs provided in the ER, as summarized below (NRC, 2009a; NRC, 2009b).

- SAMA 41, provide capability for alternate injection via the reactor water cleanup (RWCU), was initially evaluated as being beneficial only for events involving steamline breaks or stuck open safety relief valves. In response to an RAI, FPL-DA indicated that this treatment was based on interpreting the generic SAMA as providing a means of heat removal and not a source of injection, and that the RWCU system is not capable of being used for injection (NextEra, 2009a). However, in another response, the cost estimate was stated to include some of the modifications necessary to use it for injection (NextEra, 2009a). Although the benefit associated with a SAMA based on use of the RWCU for injection was not provided by FPL-DA (NextEra, 2009b), this benefit can be estimated from the assessed benefits of other SAMAs. This is discussed in Section G 6.2.

- SAMA 117, increase boron concentration or enrichment, was initially evaluated by eliminating mechanical failures of the standby liquid control (SLC) system rather than reducing the human error probability associated with initiating SLC (NextEra, 2009a). FPL-DA revised this evaluation in response to an RAI which pointed out that increasing boron concentration or enrichment would provide more time for the operator to act but would not prevent mechanical failures. The reevaluation, based on the RRW of the operator's failure to inject stand-by liquid control early, indicated a 9.9 percent reduction in CDF and a benefit of approximately $200,000 (NextEra, 2009b). This is discussed in Section G 6.2.

- SAMA 164, improve the reliability of the river water system (RWS) control system, was evaluated by revising the base case PRA to more accurately reflect the current primary and backup RWS control system, and further modifying this model to account for SAMA implementation. The original base case PRA model included the primary automatic control system, whose failure had a RRW that led to the identification of the SAMA. FPL-DA added an independent backup control system to the base case model with an assumed reliability equal to that of the primary system. This reduced the importance of the primary control system and thus the benefit that could result from further improvements (NextEra 2009a, 2009b). The NRC staff concludes that this approach to evaluating the risk reduction of this SAMA was acceptable.

The NRC staff has reviewed FPL-DA's bases for calculating the risk reduction for the various plant improvements and concludes, with the above clarifications, that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on FPL-DA's risk reduction estimates.

F.5. Cost Impacts of Candidate Plant Improvements

FPL-DA estimated the minimum implementation costs for a procedure change, including training on the procedure, to be $30,000 and for an integrated hardware modification, including associated training, to be $100,000. If the calculated benefit exceeded these minimum implementation costs then an expert panel further assessed the SAMA.

The expert panel consisted of plant staff familiar with design, construction, operation, training and maintenance. The expert panel in their assessment discussed a conceptual design and degree of complexity to implement the SAMA under consideration. The panel then chose a similarly complex design modification that had been completed at DAEC and used the actual cost for this modification as the cost of implementing the SAMA. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles. The cost estimates provided in the ER did not account for inflation (NextEra, 2009b). For some SAMAs, particularly when evaluating the cost benefit associated with sensitivity studies, other licensees' estimates for similar improvements were cited to indicate that the DAEC cost estimates were too low. A member of the Design Engineering department reviewed the cost estimates for four SAMAs (SAMAs 12, 78, 156 and 168) to provide further assurance that the estimates were sufficiently accurate for cost benefit decision making purposes.

The NRC staff reviewed the bases for the licensee's cost estimates (presented in Table 7.1.3-1 of Appendix F to the original ER) and requested more information concerning the design and associated cost for a number of the SAMAs. Also, for a number of SAMAs where the cost was given only as greater than the MAB, the NRC staff requested specific dollar cost estimates (NRC, 2009a). In response, FPL-DA described in general terms the nature of the modification required to implement the SAMA to support the expert panel's judgment on the cost, and in some cases cited DAEC experience with similar modifications and/or cost estimates given in other SAMA evaluations (NextEra, 2009a). For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensee's analyses of SAMAs for operating reactors and advanced light-water reactors. The staff reviewed the costs and found them to be reasonable, and generally consistent with estimates provided in support of other plants' analyses. Updated cost estimates provided in support of the NRC staff review were incorporated in the first annual update of the License Renewal Application (NextEra, 2009c) and are reflected in Table G-6.

The NRC staff concludes that the cost estimates provided by FPL-DA are sufficient and appropriate for use in the SAMA evaluation.

Table G-6. Severe Accident Mitigation Alternative Cost/Benefit Screening Analysis for Duane Arnold Energy Center[a]

DAEC SAMA Number Potential Improvement	Modeling Assumptions	% Risk Reduction		Total Benefit ($)		Minimum Cost[b] ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
10 - Provide an additional diesel generator	Standby diesel generators do not fail	38	41	950K	2.4M	10M
12 - Improve 4.16-kV bus cross-tie	Division 1 diesel generator does not fail	12	18	400K	1.0M	1.6M
15 - Install a gas turbine generator	Standby diesel generators do not fail	38	41	950K	2.4M	5M
17 - Install a steam-driven turbine generator that uses reactor steam and exhausts to suppression pool	Standby diesel generators do not fail	38	41	950K	2.4M	20M
27 - Install an independent active or passive high pressure injection system	Small, medium and large LOCAs, breaks outside containment, IORV and SORV sequences eliminated	26	26	570K	1.4M	20M
28 - Provide an additional high pressure injection pump with independent diesel	HPCI does not fail	37	36	810K	2.0M	10M
35 - Add signals to open relief valves automatically in an MSIV closure transient	Safety/relief valves do not fail	15	7.6	190K	460K	1M
39 - Increase flow rate of suppression pool cooling	Torus cooling always successful	8.1	8.4	170K	420K	2.3M
41[c] - Provide capability for alternate injection via reactor cleanup (RWCU)	Steam line breaks and SORV sequences eliminated	16	16	350K	860K	1.3M
	HPCI does not fail	37	36	810K	2.0M	4.0M
49 - Replace two of the four electric safety injection pumps with diesel-powered pumps	Small, medium and large LOCAs, breaks outside containment, IORV and SORV sequences eliminated	26	26	570K	1.4M	20M

DAEC SAMA Number Potential Improvement	Modeling Assumptions	% Risk Reduction		Total Benefit ($)		Minimum Cost[b] ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
52 - Replace ECCS pump motors with air-cooled motors	Small, medium and large LOCAs, breaks outside containment, IORV and SORV sequences eliminated	26	26	570K	1.4M	1.5M
55 - Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers	RHR Service Water System does not fail	4.7	8.7	160K	390K	500K
56 - Add a service water pump	RHR Service Water System does not fail	4.7	8.7	160K	390K	1M
75 - Install an independent method of suppression pool cooling	Torus cooling always successful	8.1	8.4	170K	420K	1M
78 - Enable flooding of the drywell head seal	Failures of the drywell head flange seal eliminated	0.0	1.8	25K	65K	100K
107 - Increase leak testing of valves in interfacing system loss of coolant accident (ISLOCA) paths	Interfacing System LOCA initiated sequences eliminated	0.6	0.5	11K	26K	2.3M
117 - Increase boron concentration or enrichment in the SLC system	Human error failure to inject stand-by liquid control early eliminated[d]	9.9	[e]	200K	500K	400K
120 - Add a system of relief valves to prevent equipment damage from pressure spikes during ATWS	ATWS events do not occur	30	26	590K	1.5M	5M
123 - Install an ATWS sized filtered containment vent to remove decay heat	ATWS events do not occur	30	26	590K	1.5M	3M
139 - Install digital large break LOCA protection system	Small, medium and large LOCAs, breaks outside containment, IORV and SORV sequences eliminated	26	26	570K	1.4M	13M
156 - Provide an alternate source of water for the RHRSW/ESW pit (Add T-connection and valve to pipe connecting the RHRSW/ESW pit to the Circ Water pit to allow backflow from the Circ Water pit to the RHRSW/ESW pit)	All failures of RWS system eliminated	13	15	320K	800K	250K

DAEC SAMA Number Potential Improvement	Modeling Assumptions	% Risk Reduction		Total Benefit ($)		Minimum Cost[(b)] ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
163 - Improve the reliability of the RWS system control valves CV4914 and CV4915	All failures of RWS system eliminated	13	15	320K	800K	1M
164 - Improve the reliability of the RWS control system	Failure of hand switches for both RWS supply valves to stilling basin eliminated from revised SAMA baseline model modified to include backup redundant controls not included in original baseline model	0.4	0.5	10K	25K	100K
166 - Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of the low pressure permissive	All failures of the low pressure ECCS low reactor pressure permissive switches eliminated	6.4	13	280K	690K	250K

(a) SAMAs in bold are potentially cost-beneficial

(b) Minimum cost values are based on information provided in response to RAIs and incorporated in updated ER (NextEra 2009a, 2009c)

(c) For SAMA 41 the benefit reported in the ER is based on mitigating only steam break. An RAI response provided an estimated cost for an enhanced modification but no associated benefit information (NextEra, 2009b). The benefit for this enhanced modification was estimated by NRC staff. See Section G 6.2.

(d) Analysis revised in response to an RAI (NextEra, 2009b)

(e) Not provided. See Section G 6.2

F.6. Cost-Benefit Comparison

FPL-DA's cost-benefit analysis and the NRC staff's review are described in the following sections.

F.6.1. FPL Energy Duane Arnold, LLC's Evaluation

The method used by FPL-DA was based primarily on NRC's guidance for analyzing cost-benefit analysis, (i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook*) (NRC, 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) – COE, where,

APE = present value of averted public exposure ($)

AOC = present value of averted offsite property damage costs ($)

AOE = present value of averted occupational exposure costs ($)

AOSC = present value of averted onsite costs ($)

COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. FPL-DA's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC, 2004). FPL-DA analyzed the SAMA using 7 percent and provided a sensitivity analysis using the 3 percent discount rate in order to capture SAMAs that may be cost-effective using the lower discount rate, as well as the higher, baseline rate. In addition, FPL-DA provided the results of a sensitivity study using an 8.5 percent discount rate which was being used by FPL-DA for project cost estimating purposes at the time of the submittal (FPL-DA, 2008). This analysis is sufficient to satisfy NRC policy in Revision 4 of NUREG/BR-0058.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)

x monetary equivalent of unit dose ($2,000 per person-rem)

x present value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate)

As stated in NUREG/BR-0184 (NRC, 1997a), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents, FPL-DA calculated an APE of approximately $666,000 for the 20-year license renewal period (including the 1.57 factor to account for external events).

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction

x offsite economic costs associated with a severe accident (on a per event basis)

x present value conversion factor

This term represents the sum of the frequency-weighted offsite economic costs for each release category, as obtained for the Level 3 risk analysis. For the purposes of initial screening, which assumes all severe accidents are eliminated, FPL-DA calculated an annual offsite economic risk of about $76,700 based on the internal events Level 3 risk analysis. This results in a discounted value of approximately $1,290,000 for the 20-year license renewal period (including the 1.57 factor to account for external events).

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction

x occupational exposure per core damage event

x monetary equivalent of unit dose

x present value conversion factor

FPL-DA derived the values for AOE from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, FPL-DA calculated an AOE of approximately $6,500 for the 20-year license renewal period (including the 1.57 factor to account for external events).

Averted Onsite Costs

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only, not for severe accidents. FPL-DA derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook (NRC 1997a).

FPL-DA divided this cost element into two parts – the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs (ACC), and the replacement power cost (RPC).

ACCs were calculated using the following formula:

ACC= Annual CDF reduction

x present value of cleanup costs per core damage event

x present value conversion factor

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension.

Long-term RPCs were calculated using the following formula:

RPC= Annual CDF reduction

x present value of replacement power for a single event

x factor to account for remaining service years for which replacement power is required

x reactor power scaling factor

FPL-DA based its calculations on a DAEC net output of 610 megawatt-electric (MWe) and scaled down from the 910 MWe reference plant in NUREG/BR-0184 (NRC, 1997a). Therefore FPL-DA applied a power scaling factor of 610/910 to determine the replacement power costs. The DAEC net output is stated to include a planned power uprate.

For the purposes of initial screening, which assumes all severe accidents are eliminated, FPL-DA calculated AOSC of approximately $296,000 for the 20-year license renewal period (including the 1.57 factor to account for external events).

Using the above equations, FPL-DA estimated the total present dollar-value equivalent associated with completely eliminating severe accidents from both internal and external events at DAEC to be about $2.26M, also referred to as the Maximum Attainable Benefit (MAB).

<u>FPL-DA's Results</u>

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a 7 percent discount rate, and considering the impact of external events), FPL-DA identified two potentially cost-beneficial SAMAs. The potentially cost-beneficial SAMAs are:

- SAMA 156 – Provide an alternate source of water for the RHRSW/ESW pit
- SAMA 166 – Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.

FPL-DA analyzed additional analyses to evaluate the impact of parameter choices (alternative discount rates and remaining plant life) and uncertainties on the results of the SAMA assessment. For the Phase I screening, FPL-DA assumed that there was sufficient margin in the maximum benefit estimation that this screening would not be impacted by the sensitivity and uncertainty analyses. For the Phase II cost benefit analyses, a quantitative assessment indicated that, except for SAMA 117, even with the sensitivity and uncertainty impacts considered, the costs of the originally non-cost beneficial SAMAs exceed the benefits and no additional SAMA candidates were determined to be potentially cost-beneficial (FPL-DA, 2008). As discussed above, the benefit of SAMA 117, increase boron concentration or enrichment, was originally underestimated in the ER. FPL-DA provided a revised benefit estimate in response to an NRC staff RAI and concluded that this SAMA would also be potentially cost-beneficial when considering the impact of uncertainties (NextEra, 2009b).

FPL-DA indicated that they plan to further evaluate these SAMAs for possible implementation, and have included these items in FPL-DA's corrective action program (FPL-DA, 2008; NextEra, 2009b).

The potentially cost-beneficial SAMAs and FPL-DA's plans for further evaluation of these SAMAs are discussed in detail in Section G.6.2.

F.6.2. Review of FPL Energy Duane Arnold, LLC's Cost-Benefit Evaluation

The cost-benefit analysis analyzed by FPL-DA was based primarily on NUREG/BR-0184 (NRC, 1997a) and the NRC staff review stated the analysis was conducted consistent with this guidance.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC, 2004). FPL-DA provided a base set of results using the 7 percent discount rate and a sensitivity study using the 3 percent discount rate (FPL-DA, 2008).

SAMAs identified primarily on the basis of the internal events analysis could provide benefits in certain external events, in addition to internal events. To account for the additional benefits in external events, FPL-DA multiplied the internal event benefits for each internal event SAMA by a factor of 1.57, which is the ratio of the total CDF from internal and external events to the internal event CDF. This factor was based on a combined fire and seismic CDF from the DAEC external events PRA (3.74×10^{-6} per year rounded up to 4×10^{-6} per year) plus the high wind and tornado CDF from the IPEEE (1.4×10^{-7} per year rounded up to 2×10^{-7} per year) plus the screening values for external flooding and transportation events (1 x 10^{-6} per year for each). The external event CDF is thus 56.4 percent of the internal events CDF (1.08 x 10^{-6} per year rounded up to 1.1 x 10^{-6} per year). The total CDF is thus 1.564 times the internal events CDF and this was rounded up to 1.57 (NextEra, 2009a).

Potential benefits in external events were estimated in this manner, since the external-event models are generally less detailed than the internal-event models, do not lend themselves to quantifying the benefits of the specific plant changes associated with internal-event SAMAs and for DAEC, the external events models were not extended to incorporate the assessment of releases to the environment. For example, the benefits of a procedural change associated with an important internal event sequence cannot be readily assessed using the seismic-risk model if that operator action or system is not represented in the seismic-risk model. The use of a multiplier on the benefits obtained from the internal events PRA to incorporate the impact of external events implicitly assumes that each SAMA would offer the same percentage reduction in external-event CDF and population dose as it offers in internal events. While this provides only a rough approximation of the potential benefits, such an adjustment was considered appropriate given the lack of information on which to base a more precise risk reduction estimate for external events. In view of the licensee's further evaluation of the impacts of the use of a multiplier on the SAMA screening (as part of the uncertainty assessment discussed below), the NRC staff agrees that the use of such a multiplier for external events is reasonable.

FPL-DA analyzed additional SAMA sensitivity issues, including use of a 3 percent discount rate, use of a longer plant life, and use of different evacuation assumptions. It also considered the impact of unresolved peer review findings and recent plant modifications on the results of the SAMA analysis. These analyses did not identify additional potentially cost-beneficial SAMAs beyond those already identified.

FPL-DA considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, FPL-DA states that upper bound benefits were estimated by multiplying the results using the mean risk values by an uncertainty factor of 2.5. This factor was stated to be based on a review of similar PRAs. While the factor does not represent an upper bound, it does represent the ratio of the 95th percentile CDF to the mean CDF and is considered by the NRC staff to be appropriate for use in the SAMA sensitivity analyses.

FPL-DA's conclusion that there was sufficient margin in the maximum benefit estimation that the Phase I screening would not be impacted by the sensitivity and uncertainty analyses was reviewed by the NRC staff and further information was requested in an RAI (NRC, 2009a). FPL-DA indicated that the MAB was predicated on the basis of elimination of all the risk, that none of the Phase I SAMAs screened out (based on exceeding the MAB) would be expected to achieve more than about a 37 percent reduction in risk (equal to elimination of all loss of offsite peer risk), and that all of the screened SAMAs involve complex design changes with a correspondingly high cost (NextEra, 2009a). Based on the additional information provided, the NRC staff agrees with the conclusion that the sensitivity and uncertainty analyses will not result in any additional Phase I SAMAs being retained for further evaluation in the Phase II cost-benefit analyses.

As indicated in Section G 2.2, the NRC staff developed an independent conservative assessment of the seismic CDF that is approximately an order of magnitude greater than that indicated by the DAEC seismic PRA. If this higher value is used, the external events multiplier would be increased to 2.3 (from the value of 1.57 used in the ER analysis). The NRC staff requested that FPL-DA assess the impact on SAMA analysis results if this higher multiplier were used in the cost-benefit analysis. In response, FPL-DA indicated that only three SAMAs would become potentially cost-beneficial using the higher external events multiplier combined with the CDF uncertainty factor described above, (i.e., SAMAs 52, 53, and 163). For SAMA 52, replace ECCS pump motors with air-cooled motors, and for SAMA 55, implement modifications to allow manual alignment of the fire water system to RHR heat exchangers, FPL-DA provided updated cost estimates from other SAMA evaluations for similar modifications that were considerably higher than those originally estimated for DAEC. Based on the updated cost estimates, these SAMAs would not be cost-beneficial even for the higher external events multiplier combined with the CDF uncertainty factor. For SAMA 163, improve the reliability of the RWS system control valves; the benefit was originally assessed assuming that the modification would eliminate all risk associated with the RWS system. FPL-DA argued that based on a more realistic estimate of the risk reduction, this SAMA would also not be cost beneficial even for the higher external events multiplier combined with CDF uncertainty (NextEra, 2009a). The NRC staff agrees with these conclusions.

As indicated in Section G 4, the NRC staff questioned FPL-DA on the risk reduction potential for certain SAMAs, as summarized below.

- For SAMA 41, provide capability for alternate injection via the reactor water cleanup (RWCU), the ER reported a benefit of $345 thousand and an implementation cost of $1.3 million assuming the SAMA is only beneficial in events involving steamline breaks or stuck open safety relief valves. In response to an NRC staff RAI, FPL-DA indicated that the cost associated with modifying the RWCU to allow injection at higher pressures would increase to $4 million (NextEra 2009b). While FPL-DA did not provide a revised assessment of the benefit associated with the more capable RWCU modification, the NRC estimates that the benefit for the more extensive RWCU modification would be between that determined for SAMA 27 for an independent active or passive high pressure injection system ($570 thousand) and that for SAMA 28 for an additional high pressure injection pump with independent diesel ($814 thousand). The NRC staff concludes that the more extensive modification for SAMA 41 would not be cost beneficial for the base evaluation or for any of the sensitivity study or uncertainty cases.

- For SAMA 117, increase boron concentration or enrichment. The evaluation reported in the ER assumed that this SAMA eliminated mechanical failures of the standby liquid control (SLC) system rather than reduce human errors associated with initiating SLC. When reevaluated based on the RRW of the operator’s failure to inject SLC early, FPL-DA indicated that this SAMA would provide a 9.9 percent reduction in CDF and a benefit of approximately $200 thousand (NextEra, 2009b). Considering uncertainty, this benefit could increase to $500K. Since the cost for implementing this SAMA is $400 thousand, FPL-DA concluded that this SAMA would be potentially cost-beneficial. FPL-DA has indicated that this SAMA has been included in the site corrective action program for further evaluation (NextEra, 2009b).

The NRC staff noted that for certain SAMAs considered in the ER, there may be alternatives that could achieve much of the risk reduction at a lower cost. The NRC staff asked the licensee to evaluate several lower cost alternatives to the SAMAs considered in the ER, including SAMAs that had been found to be potentially cost-beneficial at other BWR plants. These alternatives included: (1) the use of a portable diesel driven pump for low pressure injection through existing systems, (2) use of a portable diesel driven pump to provide makeup to the RHRSW/ESW pit, (3) use of a portable DC power supply to maintain DC power availability for SBO sequences, (4) improve the reliability of cross-ties between the RHR system and the RHR service water, the fire system or other systems that could be used for alternate low pressure injection, and (5) create a procedure to maximize CRD flow to provide early and/or late injection.

FPL-DA addressed each of these alternatives and stated that each has been implemented by DAEC procedures. For item 4, FPL-DA described the steps already in place to ensure the reliability of the RHR cross-ties. No additional reliability improvements were identified. The NRC staff concludes that these alternative SAMAs have been satisfactorily addressed.

FPL-DA indicated that the three potentially cost-beneficial SAMAs (i.e., SAMAs 117, 156 and 166) have been entered in DAEC's site corrective action program for further consideration (FPL-DA, 2008; NextEra, 2009b).

The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs evaluated would be higher than the associated benefits.

F.7. Conclusions

FPL-DA compiled a list of 167 SAMAs based on a review of: (1) the most significant basic events from the plant-specific PRA, (2) insights from the plant-specific IPE and IPEEE, (3) the generic SAMA candidates from NEI 05-01, and (4) a review of the generic and site-specific SAMAs by an expert panel to identify any additional candidates. A qualitative screening removed SAMA candidates that: (1) are not applicable to DAEC due to design differences, (2) have already been implemented at DAEC, (3) are similar and could be combined with another SAMA, and (4) have excessive implementation costs that will obviously exceed the maximum benefit. Based on this screening, 143 SAMAs were eliminated leaving 24 candidate SAMAs for evaluation.

For the remaining SAMA candidates, a more detailed design and cost estimate were developed as shown in Table G-6. The cost-benefit analyses in the ER showed that two of the SAMA candidates were potentially cost-beneficial in the baseline analysis (i.e., Phase II SAMAs 156 and 166). FPL-DA analyzed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. One additional SAMA (i.e., SAMA 117) was identified as potentially cost-beneficial in the ER. FPL-DA has indicated that these potentially cost-beneficial SAMAs have been entered into the DAEC site corrective action program for further consideration.

The NRC staff reviewed the FPL-DA analysis and concludes that the methods used and the implementation of those methods was sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations analyzed by FPL-DA are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, and inclusion of a multiplier to account for external events.

The NRC staff concurs with FPL-DA's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by FPL-DA is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations* (CFR), Part 54.

F.8. References

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11. ABSTRACT *(200 words or less)*

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by FPL Energy Duane Arnold, LLC (FPL-DA) to renew the operating license for Duane Arnold Energy Center (DAEC) for an additional 20 years.

This draft SEIS provides a preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired generation or natural gas combined-cycle generation plant; this is followed by a combination of alternatives that includes some energy conservation/energy efficiency measures, natural gas-fired capacity, and a wind power component. The analysis also evaluates the environmental effects that could occur if the U.S. Nuclear Regulatory Commission (NRC) takes no action to issue a renewed license for DAEC (No-Action alternative). Section 8.4 explains why the staff dismissed many other alternatives from in-depth consideration.

The preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for DAEC are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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