Applicant's Environmental Report –
Operating License Renewal Stage
Duane Arnold Energy Center
FPL Energy Duane Arnold, LLC

Unit 1
Docket No. 05000331
License No. DPR-49

September 2008

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ACRONYMS AND ABBREVIATIONS

AC&H	Archaeological, Cultural, and Historic
AEC	U.S. Atomic Energy Commission
AQCR	Air Quality Control Region
AWEA	American Wind Energy Association
BWR	Boiling Water Reactor
CCP	Coal Combustion Product
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	Carbon monoxide
CRWD	Cedar Rapids Water Department
CSFCC	California Stationary Fuel Cell Collaborative
CWA	Clean Water Act
DAEC	Duane Arnold Energy Center
DDT	Dichloro-Diphenyl-Trichloroethane
DOE	U.S. Department of Energy
DOT	Department of Transportation
DSM	demand-side management
EC	Environmental Coordinator
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
EPU	Extended Power Uprate
ESW	emergency service water
°F	degrees Fahrenheit
FES	Final Environmental Statement
FPL-DA	FPL Energy Duane Arnold, LLC
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
GIS	Geographic Information System
gpd	gallons per day
gpm	gallons per minute
GWh	gigawatt-hours
IBI	Index of Biotic Integrity
ICC	Iowa Conservation Commission
IDNR	Iowa Department of Natural Resources
IDPH	Iowa Department of Public Health
IEEE	Institute of Electrical and Electronics Engineers

ACRONYMS AND ABBREVIATIONS (CONTINUED)

IPA	Integrated Plant Assessment
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination for External Events
IPL	Interstate Power and Light
ITC	ITC Midwest, LLC
kV	kilovolt
LOS	level of service
Mg	million gallons
MSA	Metropolitan Statistical Area
msl	mean sea level
MW	megawatt
MWd/MtU	megawatt-days per metric ton uranium
MWe	megawatts-electrical
MWt	megawatts-thermal
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESC®	National Electrical Safety Code®
NMC	Nuclear Management Company
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NSPS	New Source Performance Standards
NSSS	Nuclear steam supply system
NAWQA	National Water Quality Assessment
PM	Particulate Matter
PM_{10}	Particulate matter with aerodynamic diameters of 10 microns or less
$PM_{2.5}$	Particulate matter with aerodynamic diameters of 2.5 microns or less
PPA	power purchase agreement
RBCCW	Reactor Building Closed Cooling Water
RHR	residual heat removal
RHRSW	residual heat removal service water
ROI	Region of Interest
ROW	right-of-way
SAMA	Severe Accident Mitigation Alternatives

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SCR	selective catalytic reduction
SHPO	State Historic Preservation Officer
SMITTR	surveillance, monitoring, inspections, testing, trending, and recordkeeping
SO_2	sulfur dioxide
SO_x	Sulfur oxides
STP	sewage treatment plant
TtNUS	Tetra Tech NUS, Inc.
UI	University of Iowa
USCB	U.S. Census Bureau
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

1.1 PURPOSE OF AND NEED FOR ACTION

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. FPL Energy Duane Arnold, LLC (FPL-DA) operates the Duane Arnold Energy Center (DAEC) Unit 1, pursuant to NRC Operating License DPR-049. The license for Unit 1 will expire February 21, 2014. FPL-DA has prepared this environmental report in conjunction with its application to NRC to renew the DAEC operating license, as provided by the following NRC regulations:

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

NRC has defined the purpose and need for the proposed action, the renewal of the operating license for nuclear power plants such as DAEC, as follows:

> "...The purpose and need for the proposed action (renewal of an operating 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." (NRC 1996a)

The renewed operating license would allow an additional 20 years of plant operation beyond the current DAEC licensed operating period of approximately 40 years.

1.2 ENVIRONMENTAL REPORT SCOPE AND METHODOLOGY

NRC regulations for domestic licensing of nuclear power plants require environmental review of applications to renew operating license. The NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document entitled Applicant's Environmental Report - Operating License Renewal Stage. In determining what information to include in the DAEC Environmental Report, FPL-DA has relied on NRC regulations and the following supporting documents that provide additional insight into the regulatory requirements:

- NRC supplemental information in the Federal Register (NRC 1996a, 1996b, 1996c, 1996d, and 1999a)
- Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996e and 1999b)
- Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses (NRC 1996f)
- Public Comments on the Proposed 10 CFR Part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response (NRC 1996g)
- Supplement 1 to Regulatory Guide 4.2, Preparation of Supplemental Environmental Report for Applications to Renew Nuclear Power Plant Operating Licenses (NRC 2000)

FPL-DA has prepared Table 1.2-1 to verify conformance with regulatory requirements. Table 1.2-1 indicates where the environmental report responds to each requirement of 10 CFR 51.53(c). In addition, each responsive section is prefaced by a boxed quote of the regulatory language and applicable supporting document language.

TABLE 1.2-1
ENVIRONMENTAL REPORT RESPONSES TO LICENSE RENEWAL ENVIRONMENTAL REGULATORY REQUIREMENTS

Regulatory Requirement	Responsive Environmental Report Section(s)	
10 CFR 51.53(c)(1)		Entire Document
10 CFR 51.53(c)(2), Sentences 1 and 2	3.0	Proposed Action
10 CFR 51.53(c)(2), Sentence 3	7.2.2	Environmental Impacts of Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(1)	4.0	Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(2)	6.3	Unavoidable Adverse Impacts
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(3)	7.0	Alternatives to the Proposed Action
	8.0	Comparison of Environmental Impacts of License Renewal with the Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(4)	6.5	Short-Term Use Versus Long-Term Productivity of the Environment
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(5)	6.4	Irreversible and Irretrievable Resource Commitments
10 CFR 51.53(c)(2) and 10 CFR 51.45(c)	4.0	Environmental Consequences of the Proposed Action and Mitigating Actions
	6.2	Mitigation
	7.2.2	Environmental Impacts of Alternatives
	8.0	Comparison of Environmental Impacts of License Renewal with the Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(d)	9.0	Status of Compliance
10 CFR 51.53(c)(2) and 10 CFR 51.45(e)	4.0	Environmental Consequences of the Proposed Action and Mitigating Actions
	6.3	Unavoidable Adverse Impacts
10 CFR 51.53(c)(3)(ii)(A)	4.1	Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a Small River with Low Flow)
	4.6	Groundwater Use Conflicts (Plants Using Cooling Towers or Cooling Ponds and Withdrawing Makeup Water from a Small River)
10 CFR 51.53(c)(3)(ii)(B)	4.2	Entrainment of Fish and Shellfish in Early Life Stages (Plants With Once-through Cooling or Cooling Ponds)
	4.3	Impingement of Fish and Shellfish (Plants With Once-through Cooling or Cooling Ponds)
	4.4	Heat Shock (Plants With Once-through Cooling or Cooling Ponds)
10 CFR 51.53(c)(3)(ii)(C)	4.5	Groundwater Use Conflicts (Plants Using >100 gpm of Groundwater)
	4.7	Groundwater Use Conflicts (Plants Using Ranney Wells)
10 CFR 51.53(c)(3)(ii)(D)	4.8	Degradation of Groundwater Quality (Plants Using Cooling Ponds At Inland Sites)

TABLE 1.2-1 (CONTINUED)
ENVIRONMENTAL REPORT RESPONSES TO LICENSE RENEWAL ENVIRONMENTAL REGULATORY REQUIREMENTS

Regulatory Requirement	Responsive Environmental Report Section(s)	
10 CFR 51.53(c)(3)(ii)(E)	4.9	Impacts of Refurbishment on Terrestrial Resources
	4.10	Threatened or Endangered Species
10 CFR 51.53(c)(3)(ii)(F)	4.11	Air Quality During Refurbishment (Non-Attainment Areas)
10 CFR 51.53(c)(3)(ii)(G)	4.12	Impacts on Public Health of Microbiological Organisms
10 CFR 51.53(c)(3)(ii)(H)	4.13	Electric Shock from Transmission-Line-Induced Currents
10 CFR 51.53(c)(3)(ii)(I)	4.14	Housing Impacts
	4.15	Public Utilities: Public Water Supply Availability
	4.16	Education Impacts from Refurbishment
	4.17	Offsite Land Use
10 CFR 51.53(c)(3)(ii)(J)	4.18	Transportation
10 CFR 51.53(c)(3)(ii)(K)	4.19	Historical and Archaeological Resources
10 CFR 51.53(c)(3)(ii)(L)	4.20	Severe Accident Mitigation Alternatives
10 CFR 51.53(c)(3)(iii)	4.0	Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(3)(iv)	6.2	Mitigation
	5.0	Assessment of New and Significant Information
10 CFR 51, Appendix B, Table B-1, Footnote 6	2.6.2	Minority and Low-Income Populations

1.3 DUANE ARNOLD ENERGY CENTER LICENSEE AND OWNERSHIP

Ownership of DAEC is shared by FPL-DA, Palo, Iowa (70 percent), Central Iowa Power Cooperative, Cedar Rapids, Iowa (20 percent), and Corn Belt Power Cooperative, Humboldt, Iowa (10 percent). FPL Energy Duane Arnold, LLC is a subsidiary of FPL Energy, LLC, which is a subsidiary of FPL Group, Inc. based in Juno Beach, Florida. FPL Group, Inc. generates electricity at power plants in the southeastern and northeastern United States; operates wind power throughout the Midwest; and delivers energy to customers in over 26 states including Iowa, Wisconsin, Minnesota, North Dakota, South Dakota, Kansas, New Hampshire, and Florida (FPL 2006). FPL-DA is the licensed operator of DAEC (NRC 2006).

Transmission assets at 34.5 kilovolts or higher were sold by Interstate Power and Light, a subsidiary of Alliant Energy, to ITC Midwest LLC in December of 2007. This included transmission lines, transmission substations, and associated land rights, contracts, permits, and equipment. Pursuant to the agreement, Interstate Power and Light will maintain the lines and rights-of-way through 2008.

2.0 SITE AND ENVIRONMENTAL INTERFACES

2.1 LOCATION AND FEATURES

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 2.1-1). DAEC is located in a primarily rural, sparsely populated area. There are three metropolitan areas within 50 miles of the 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 2.1-2).

The site encompasses approximately 500 acres. DAEC utilizes only a small portion of the acreage for power production; the remaining portion of the land is leased to area farmers (FPL 2007a). The site boundary/exclusion area is shown in Figure 2.1-3 (DAEC 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. This strip of land is a relatively flat plain at approximately 750 feet above mean sea level (msl). The general topographical features in this portion of the Cedar River consist of broad valleys with relatively narrow flood plains. Across the 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 (DAEC 2005a).

The 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 most important single industry in the Linn County economy (USCB 2005). The smaller communities in the vicinity of the site consist of small retail business establishments.

Pleasant Creek State Recreation Area is a 1,927 acre park located 1 mile northwest of the site. 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 both a supplemental water supply for DAEC and at the same time provide regional recreation opportunities (IDNR 2007a). Recreational activities at several park areas within ten miles of the site mostly consist of boating, fishing, hunting, camping, hiking, picnicking, and swimming. Palo Marsh Wildlife Refuge, located 2 miles south of the site, is a 144-acre site featuring a wetland trail and bottomland forest for wildlife observation. The Wickiup Hill is a 563-acre natural area located across the Cedar River just east of the site which includes the 240-acre Wickiup Hill Outdoor Learning Area and 10,000 square foot Learning Center (LCCD 2007a). 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).

DAEC is the only reactor in the state and employs more than 600 Iowans (FPL 2007a). The single 610 gross megawatt-electrical (MWe) unit is a General Electric boiling water reactor of the standard BWR-4 design. Two mechanical draft cooling towers are used, drawing water from the Cedar River (Figure 2.1-3). Water used in the reactor and most other plant systems is piped in from the site's well water supply (FPL 2007a). Other site structures include 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 is located on the northern part of the site property (Figure 2.1-3).

Section 3.1 describes key features of DAEC, including reactor and containment systems, cooling water system, and transmission system.

Duane Arnold Energy Center

FIGURE 2.1-1 6-MILE VICINITY MAP

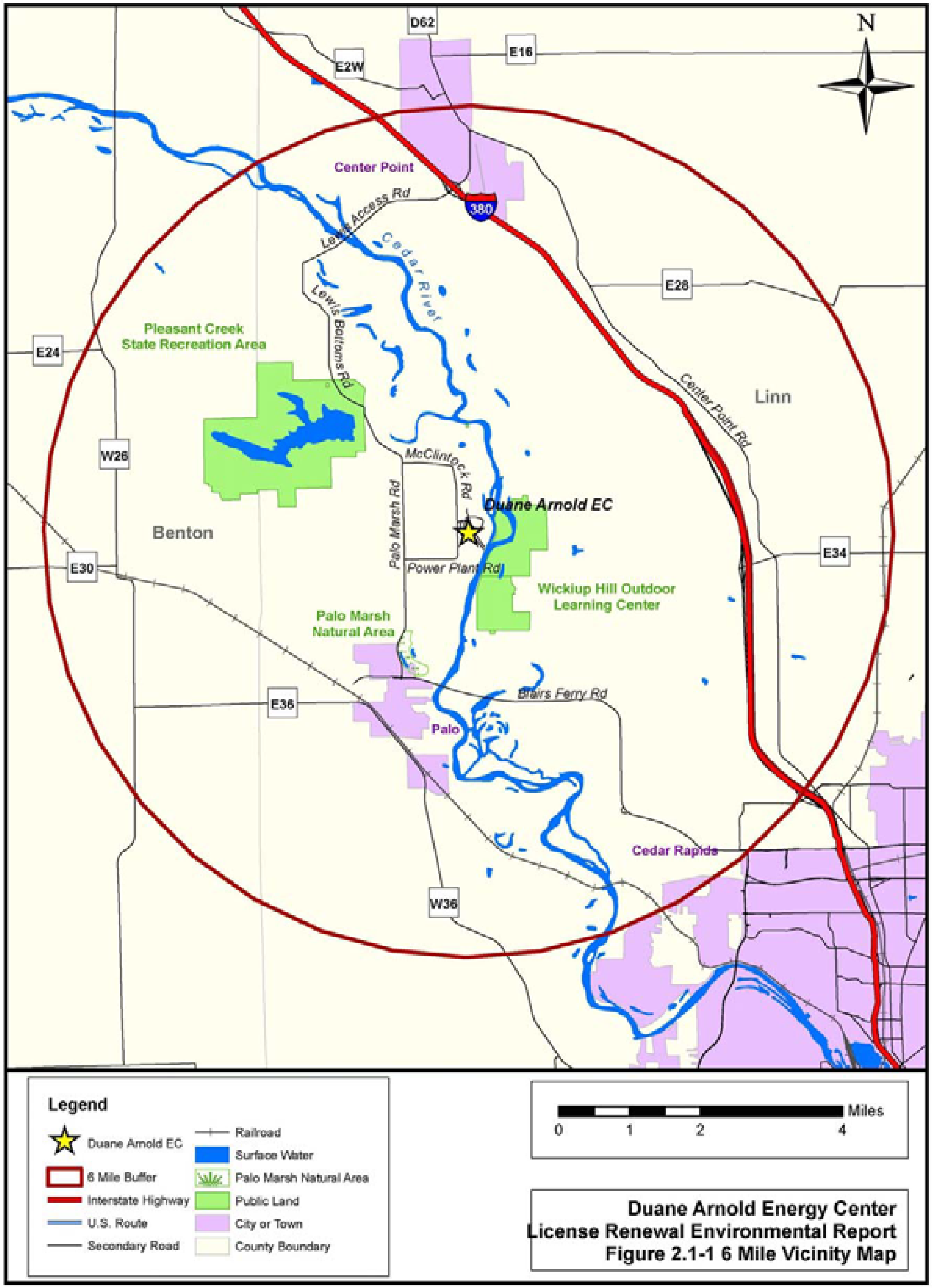


FIGURE 2.1-2 50-MILE VICINITY MAP

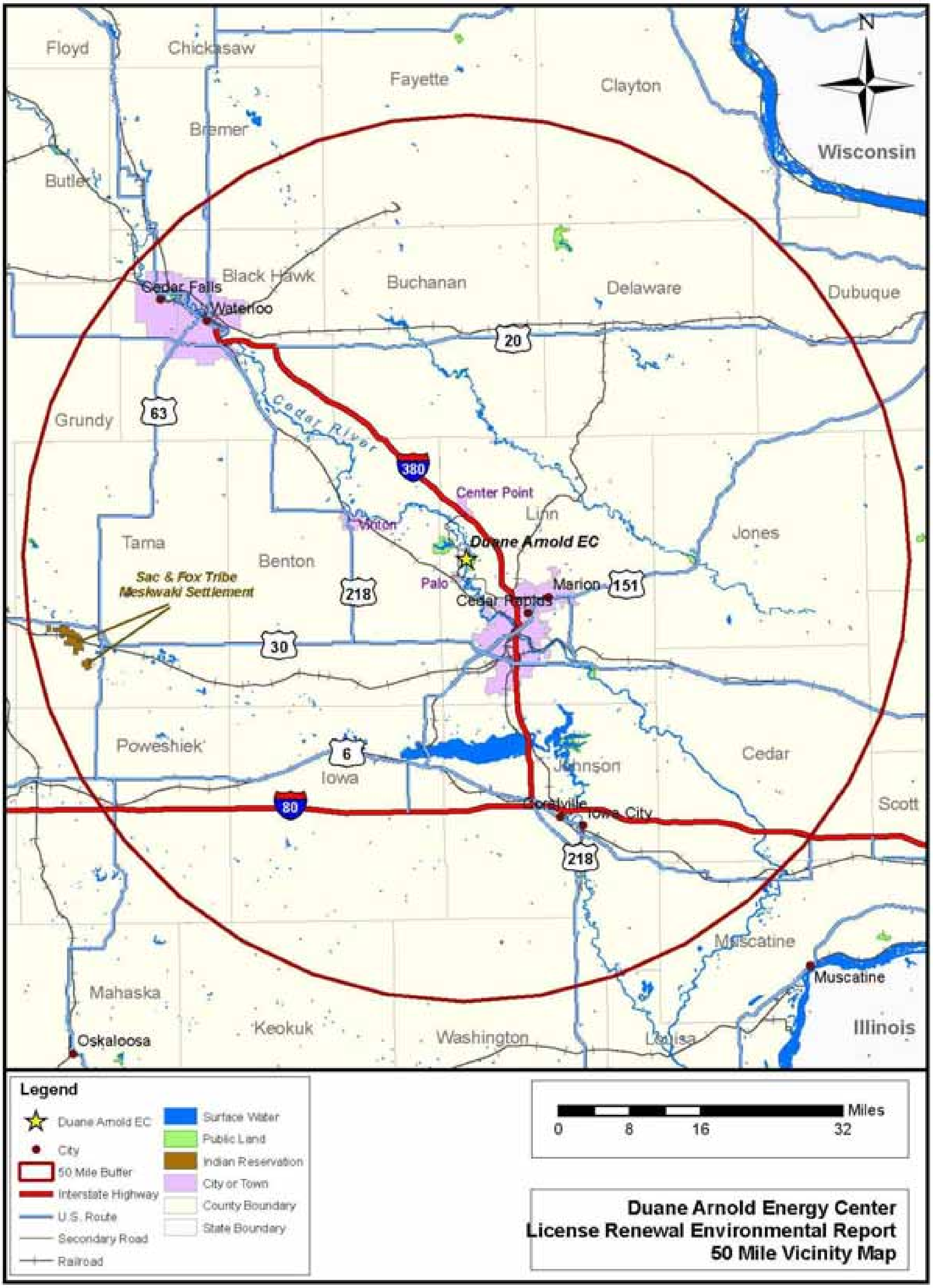
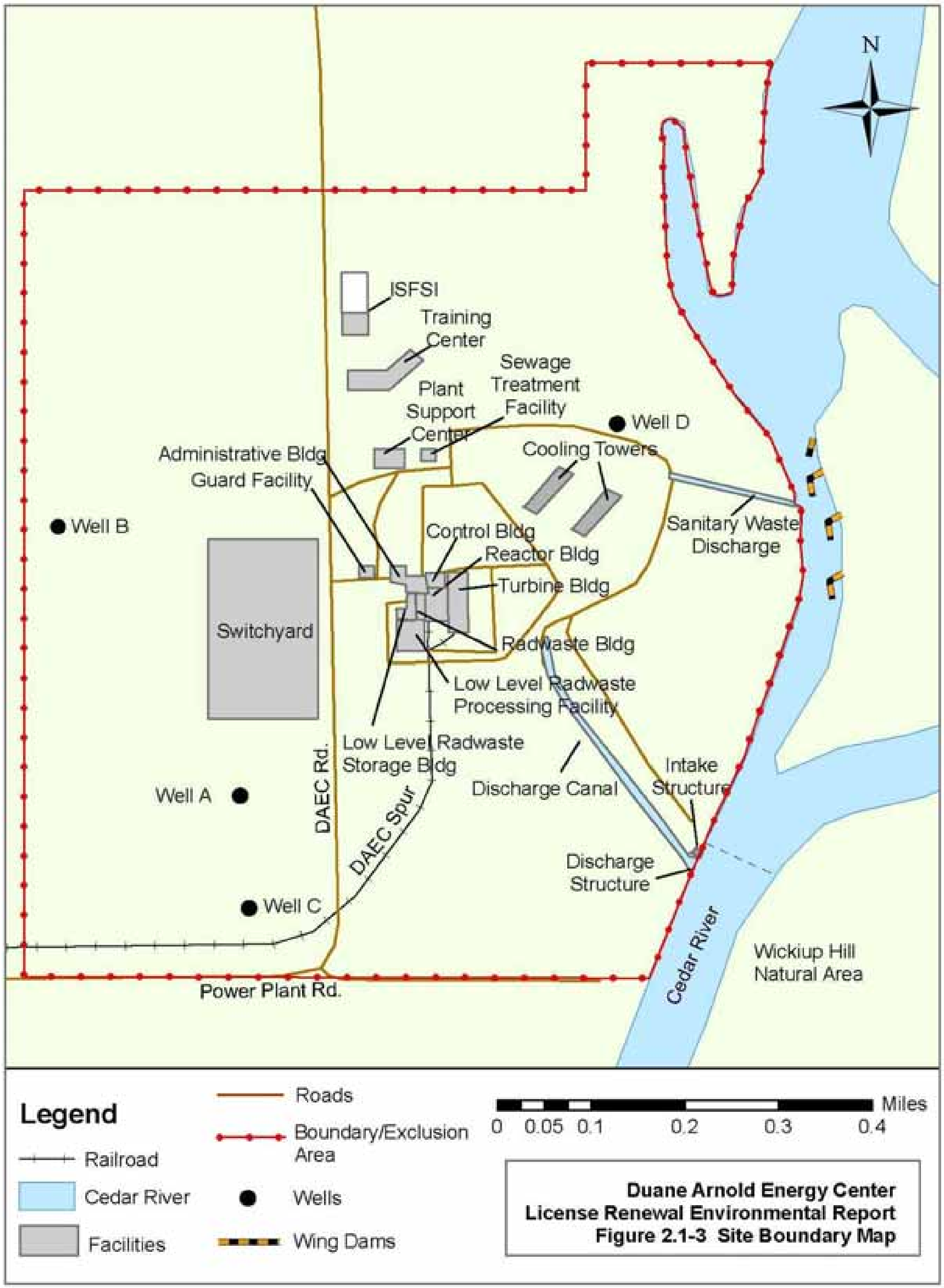


FIGURE 2.1-3 DAEC SITE BOUNDARY



2.2 AQUATIC RESOURCES

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. Flows in the river are largely a function of the amount and timing of precipitation in the watershed. Water quality in the river is affected by upstream point-source discharges (from municipal wastewater treatment plants and industrial facilities) and non-point source discharges (fertilizers and animal wastes from agricultural operations). This section characterizes the hydrology of the Cedar River and the distribution and abundance of aquatic organisms in the reach of the river adjacent to DAEC.

Description of Cedar River Basin

The Cedar River rises in southeastern Minnesota (Dodge County) and flows southeast for some 330 miles across Iowa to its confluence with the Iowa River, approximately 20 miles upstream of the point at which the Iowa River empties into the Mississippi River (Encyclopedia Britannica). The Cedar River's 7,819-square-mile drainage basin is mostly fertile farmland. More than 90 percent of the land in the region is devoted to agriculture; most of this land is in row crops (Sullivan 2000).

The U.S. Geological Survey (USGS) operates and maintains stream flow gauging stations on the Cedar River up- and downstream of DAEC. Annual mean flow at a Cedar River gauging station in Waterloo, Iowa (approximately 50 air miles upstream of DAEC) ranged from 636 to 10,580 cubic feet per second (cfs) over the 1941-2005 period and averaged 3,329 cfs (Nalley et al. 2006). Annual average flow at a Cedar River gauging station at Cedar Rapids, Iowa (approximately 15 miles downstream of DAEC) ranged from 689 to 15,130 cfs over the 1903-2005 period and averaged 3,783 cfs (Nalley et al. 2006). Several substantial tributaries flow into the 65-mile reach of river between Waterloo and Cedar Rapids: Black Hawk Creek (at Waterloo), Wolf Creek (near LaPorte City), and Prairie Creek (at Cedar Rapids).

Precipitation in Iowa averages 34 inches per year, with highest rainfall in the southeast part of the state (approximately 37 inches per year) and lowest rainfall in the northwest (approximately 29 inches per year) (Nalley et al. 2006). Annual precipitation in east-central Iowa, where DAEC is located, averaged 35.6 inches per year between 1971 and 2000 (Nalley et al. 2006). Nearly three-fourths of the state's precipitation is received during the spring-summer growing season (NCDC 2006). Cedar River flows reflect this seasonal pattern of precipitation. Flows at the Cedar Rapids gauging station from 1903 through 2005 were highest in the spring (March through June) and lowest in the fall and winter (October through January). Cedar River flows over the March-June period are typically 3 times those of the October-January period, averaging 6,221 cfs versus 2,043 cfs (Nalley et al. 2006).

Studies of Aquatic Biota

DAEC conducted pre-operational surveys of Cedar River aquatic communities from April 1971 to February 1975. This monitoring continued from the time the DAEC commenced commercial operation through 1999. The USGS conducted studies of fish community structure in the Cedar River in 1996 as part of the National Water Quality Assessment Program (NAWQA). Nuclear Management Company (NMC), which operated DAEC from May 2000 to December 2005, commissioned focused surveys of freshwater mussels in the area of the DAEC intake canal in 2002. The various aquatic surveys and studies are summarized in the sections that follow.

Benthic Macroinvertebrates

Contract biologists monitored benthic organisms in the Cedar River in the DAEC vicinity from mid-1971 through 1999 to determine if plant operations were having an effect on their distribution and abundance (McDonald 2000). It became clear in the early years of the monitoring that the shifting sand substrate in the river prevented establishment of a diverse community of benthic macroinvertebrates. In subsequent years, artificial substrates were employed upstream and downstream of the discharge canal and in the discharge canal to confirm that substrate, rather than water quality or some other factor, limited the density and diversity of macroinvertebrates. Benthic communities that developed on the artificial substrates were much larger and more diverse that those associated with the Cedar River's natural shifting sand and silt substrates. As reported by McDonald (2000), "Ponar grab samples taken from the five sites contain few if any benthic organisms, but a diverse assemblage of organisms develop on the (artificial) substrates during the six-week colonization period."

Freshwater Mussels

Frest (1987 in Helms 2003) conducted a mussel survey 1.5 miles upstream of DAEC in the area of Lewis Preserve County Park and found live representatives of 7 mussel species [plain pocketbook (*Lampsilis cardium*), white heelsplitter (*Lasmigona complanata*), fragile papershell (*Leptodea fragilis*), hickorynut (*Obovaria olivaria*), pink papershell (*Potamilis ohiensis*), pimpleback (*Cyclonaias tuberculata*), and lilliput (*Toxalasma parvus*)] and the dead shell of another species, the threeridge (*Amblema plicata*) (Frest 1987 in Helms 2003). NMC commissioned surveys of mussels along the west shore of the Cedar River upstream of the DAEC intake canal in 2002, in an area that was slated to be cleared of dead wood and snags and dredged (Helms 2003). Fourteen living mussels representing four species were collected: plain pocketbook (10 individuals), black sandshell (*Ligumia recta*; 2 individuals), pink papershell (1 individual), and white heelsplitter (1 individual). In addition, a single dead strange floater (*Strophitus undulatus*; also known as squawfoot and creeper) was collected.

The Iowa Mussel Team reviewed the status of the state's freshwater mussels in 2002 (CVRC&D 2002). The Mussel Team reported that "about half" of the freshwater mussel species found in Iowa at the time of European settlement survives today. Siltation, pollution, impoundment of rivers, and non-native invasive species were cited as the reasons for the decline of native mussels. With regard to the mussel species found by Helms in the DAEC vicinity, the Mussel Team classified them as follows:

- Plain pocketbook --- common
- Black sandshell --- uncommon
- Pink papershell --- uncommon
- White heelsplitter --- uncommon
- Strange floater/squawfoot/creeper --- threatened

Table 2.5-1 in Section 2.5 lists mussel species formally protected by the state of Iowa or the U.S. Fish and Wildlife Service that are known to occur in Linn, Benton, and Blackhawk Counties, Iowa.

Fish

The most comprehensive sources of information on fish populations in the Cedar River in the area of DAEC are the operational ecological studies conducted by Ecological Analysts, Inc., for Iowa Electric Light and Power Company over the period 1979-1983. Fish were collected in spring, summer, and fall from two locations in the Cedar River, one immediately downstream of the station's discharge canal and one approximately five miles upstream of the plant. Fish were collected by electrofishing, seining, and hoop netting, a mix of active and passive sampling techniques intended to capture fish of different sizes with different habitat preferences.

A total of 41 fish species representing 8 families were collected over the five year (1979-1983) period. Fifteen species were collected in every year of the study. In 1983, the last year for which detailed catch data is available, collections were dominated by a single species, the spotfin shiner (*Cyprinella spiloptera*). Of the 1,387 fish collected with all methods, 818 (59 percent) were spotfin shiners. The spotfin shiner is found across the Midwestern United States in small to large streams, particularly low-gradient streams (Lee et al. 1980; Loan-Wilsey et al. 2005). It is found in north-central and northeast Iowa streams, but is more abundant in large rivers like the Cedar and Iowa Rivers. Spotfin shiners have been described as "aggressive" and often outnumber other Cyprinids in waters that are turbid, silty, and organically polluted (Trautman 1957; Loan-Wilsey et al. 2005).

Other species that appeared frequently in DAEC collections included the river carpsucker (*Carpiodes carpio*; 123 fish, 8.9 percent), bullhead minnow (*Pimephales vigilax*; 83 fish, 6.0 percent), bluntnose minnow (*Pimephales notatus*; 70 fish, 5 percent), and common carp (*Cyprinus carpio*; 49 fish, 3.5 percent). The river carpsucker is found in streams and rivers across the Midwest, and "thrives in the silty, turbid waters of rivers…with slow currents over soft bottoms of sand, clay, and gravel" (Loan-Wilsey et al. 2005). The bullhead minnow is found in many tributaries of the Mississippi River, including the Cedar, Des Moines, and Iowa Rivers. It is known to be highly tolerant of turbidity and siltation (Trautman 1957; Loan-Wilsey et al. 2005). The bluntnose minnow is found in a variety of habitats across the Midwestern U.S. and is tolerant of turbidity and pollutants, both organic and inorganic (Trautman 1957; Lee et al. 1980). A hardy species, it is widely used as a bait minnow. The common carp, introduced to the U.S. in 1877, is found in streams, lakes, and impoundments across the country (Lee et al 1980). It tolerates a wide range of water quality conditions, and may thrive in polluted or eutrophic waters that exclude other, more desirable game fish species (Scott and Crossman 1973).

A variety of recreationally-important species were collected near DAEC in 1983, but only one, the channel catfish, was present in significant numbers (36 fish). Other gamefish in samples included smallmouth bass (6 fish), bluegill (5 fish), largemouth bass (4 fish), white crappie (4 fish), black crappie (3 fish), and northern pike (1 fish).

The USGS collected data on fish communities at 12 sites in 4 eastern Iowa river basins (the Wapsipinicon, the Cedar, the Iowa, and the Skunk) in 1996 as part of the NAWQA program (Sullivan 2000). Two Cedar River sites were sampled, one upstream (Site #5) and one downstream (Site #2) of DAEC. Fish communities at all the large river sites, including the two Cedar River sites, were numerically dominated by minnows (Cyprinids) and suckers (Catastomids). Minnows made up more than 42 percent of fish collected at Cedar River Site 2 (upstream of DAEC); 44.8 percent were suckers. Eight minnow species and three sucker species were collected. More than 81 percent of fish collected at Site 5 (downstream of DAEC) were minnows (8 species); approximately 15 percent were suckers (9 species). Bullhead minnows (32 percent of total) and river carpsuckers (44 percent of total) dominated collections at Cedar River Site 2; spotfin shiner (39 percent of total) and bluntnose minnow (27 percent of total) dominated collections at Cedar River Site 5 (Sullivan 2000). Based on surveys conducted at DAEC in the 1970s and 1980s, all four of these species are common in the area of the plant.

The USGS NAWQA report rated the fish communities of the two Cedar River sites as "fair," using the Index of Biotic Integrity (IBI) scoring systems of the states of Ohio and Wisconsin. The two Cedar River sites were the highest-scoring of six "large river" sites in eastern Iowa (Sullivan 2000). All other large-river sites were rated "fair" (but with lower numerical ratings) or "poor." The study listed eutrophication, toxic contamination, and soil erosion and sedimentation as factors that have degraded aquatic habitats and altered fish communities in eastern Iowa. The report notes that non-point-source pollutants have become more of a concern in recent years as improved wastewater treatment has reduced the amount of pollutants entering streams and rivers from industrial and municipal sources.

The NAWQA study published in 2000 mirrored earlier fish studies conducted by DAEC in that relatively few sport fish were collected. Channel catfish comprised nine percent of all fish collected at Cedar River Site 2, but less than one percent of fish collected at Site 5 (Sullivan 2000). Smallmouth bass made up approximately one percent of all fish collected at each site. No other recreationally important species was present in substantial numbers. The Cedar River is a popular destination for channel catfish anglers in summer, and is attracting an increasing number of smallmouth bass fishermen. Smallmouth bass are caught in all reaches of the river, including the portion of the river that moves through downtown Cedar Rapids (Patterson 2007). A recent article in Iowa Outdoors, “Fishing Forecast 2007”, urged fishermen to seek out several rivers in eastern Iowa, including the Cedar, that offer “…excellent smallmouth fishing from riffles to deeper pools…almost any type of habitat in these streams hold fish…” (IDNR 2007b).

2.3 GROUNDWATER RESOURCES

DAEC is located in the Cedar River Basin on the west bank of the Cedar River, 133.5 river miles above its confluence with the Iowa River and 5.7 miles northwest of Cedar Rapids. At the DAEC site, the Cedar River Basin drainage area is approximately 6,250 square miles. The Cedar River is the largest tributary of the Iowa River. The aquifers in the vicinity of the site include shallow unconsolidated glacial and surficial deposits, and deep underlying bedrock aquifers. The bedrock strata immediately underlying the site are the Wapsipinicon and Gower Formations, of Middle Devonian and Upper Silurian age respectively (DAEC 2005a).

The lower rock aquifer is composed of Ordovician and Cambrian rocks, which include St. Peter sandstone, Prairie du Chien dolomite and sandstone, Jordan sandstone, and St. Lawrence dolomite (DAEC 2005a).

2.3.1 GROUND WATER SUPPLY

Although the Jordan sandstone is the most prolific source of groundwater from the deep wells into the underlying bedrock aquifers, DAEC has not developed the Jordan aquifer for plant water supply because the Jordan aquifer is a sandstone aquifer that cannot tolerate excessive pumping; alternate wet and dry conditions would lead to ultimate crumbling and collapse (DAEC 2005a). Instead, DAEC production wells are located within the Devonian and Silurian age aquifers.

Adequate supplies of good water are also available from sand and gravel aquifers in the surficial deposits that overlie the bedrock. These are replenished by direct precipitation, periodic flooding, and, where adequate underground hydraulic connections with streambeds exist, by river recharge. Two shallow aquifers underlie most of the site area, an upper water table aquifer composed of fine to medium sand, and a lower artesian aquifer in weathered rock. The two aquifers are separated by 10 to 60 feet of relatively impervious clay. This clay aquiclude is believed to be continuous over most of the site area. The clay extends above and below river bottom elevation (DAEC 2005a).

Groundwater measurements indicate that flows in the upper aquifer are toward the river in a general southeasterly direction across the site. Potentiometric surface contours indicate that flows in the lower aquifer are also in this same general direction. During DAEC production well operation, no interference of the upper aquifer has been noted (DAEC 2005a).

Domestic wells within a one-mile radius west and north of the plant are upslope of the plant. Groundwater flows past these wells through the plant site or along an offsite path directly toward the river. Domestic wells southwest and south of the plant are approximately one mile away and are not in the line of groundwater flow past the plant. DAEC production wells drilled into the lower artesian Silurian-Devonian aquifer in weathered rock yield approximately 750 gallons per minute (gpm). Water analysis test reports indicate a good mineral quality (DAEC 2005a).

2.3.2 OFFSITE GROUND WATER USAGE

The primary user of groundwater in the region is the Cedar Rapids Water Department (CRWD undated). The department obtains its drinking water from the shallow sand and gravel aquifers along the Cedar River. The well system consists of 4 well fields, 4 collector wells and 45 vertical wells. Conventional lime softening is performed at 2 treatment plants and the water is distributed to 16 water towers. Serving a population of 123,000, the system has a peak flow of 50 million gallons per day (mgd), average flow of 35 mgd and could be expanded to its design capacity of 65 mgd. An additional 2,000 people are served by 2 wholesale water service agreements. Residential, commercial, and municipal customers use 25 percent of the water and 75 percent is used by 16 local industries.

2.3.3 PLANT GROUND WATER USAGE

DAEC uses 4 production wells to provide approximately 100 gpm of demineralizer makeup and less than 10 gpm of potable water. In addition, these wells supply 1,400 gpm to an air-cooling system to provide high quality, cool (55^{o}F) water to assist in the removal of heat from system components in an energy efficient manner during startup, normal operation, shutdown, and cool down (AEC 1973).

The 4 wells, designated A, B, C, and D (DAEC 2006a), range in depth from 285 feet to 380 feet (DAEC 2004a). The wells are all installed in the Silurian-Devonian aquifer.. Table 2.3-1 presents well depths and design yields.

FPL-DA reports monthly and annual water use (well, reservoir, and surface water) to the Iowa Department of Natural Resources (IDNR) on the IDNR Annual Water Use Report Form (Curtland 2006). Table 2.3-2 presents well water use for 2001 through 2005.

TABLE 2.3-1

DUANE ARNOLD ENERGY CENTER WELL SYSTEM

SDWIS ID	Local Well	Construction	Depth (Feet)	Average Flow GPM	Deep Well	Capacity (gpm)
WL04	D	1980	285	1,000	Yes	1650
WL05	B	1992	375	500	Yes	1200
WL06	C	1999	380	600	Yes	750
WL07	A	2001	375	750	Yes	750

Adapted from DAEC 2004a, DAEC 2006a & IDNR 2004b

TABLE 2.3-2
DUANE ARNOLD ENERGY CENTER WELL WATER USE

Year	2001	2002	2003	2004	2005	Average 2001-2005
Annual Use (Mg)	702	707	768	848	640	733
Continuous Average (gpm)	1,336	1,345	1,461	1,609	1,217	1,394
Maximum Monthly Use (Mg)	79.0	68.0	75.0	88.7	63.5	74.8

Adapted from Curtland 2006
Mg = million gallons

2.4 CRITICAL AND IMPORTANT TERRESTRIAL HABITATS

DAEC is located approximately 5.7 miles northwest of Cedar Rapids, Iowa, in Linn County. The total plant site covers approximately 500 acres. The DAEC site is relatively flat and slopes gradually down to the Cedar River, which forms the 1.3-mile-long eastern boundary of the property.

The DAEC was primarily farmland prior to plant construction and 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. The latter encompasses approximately 140 acres and includes facility buildings, a switchyard, parking areas, and maintained (mowed) areas. A discharge canal drains to the Cedar River.

Predominant tree species in the floodplain forests along the Cedar River include silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), box elder (*Acer negundo*) and hawthorn (*Crataegus mollis*) (Niemann and McDonald 1972). Due to the periodic flooding associated with the river floodplain, understory trees and plants in this area are sparse. Oaks (*Quercus* spp.) and hickories (*Carya* spp.) are the primary species in the remaining forested plots and field edges (AEC 1973).

The terrestrial wildlife that occurs at DAEC and the surrounding areas are those species typically found in similar habitats throughout Iowa (AEC 1973). As the result of more than a century of conversion of the native habitats to agriculture, the existing flora and fauna of the region is not diverse. Common mammals observed during wildlife surveys associated with site construction included white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*), opossum (*Didelphis virginiana*), spotted skunk (*Spilogale putorius*), and striped skunk (*Mephitis mephitis*) (Collins and McDonald 1972). Most of these were observed in the areas near the Cedar River. Common avian species observed on DAEC included meadowlark (*Sturnella* spp.), barn swallow (*Hirundo rustica*), red-wing blackbird (*Agelaius phoeniceus*), bluejay (*Cyanocitta cristata*), ring-necked pheasant (*Phasianus colchicus*), and wood duck (*Aix sponsa*). These species are still commonly observed on DAEC property by site personnel.

Ospreys (*Pandion haliaeetus*) are large, fish-eating birds that historically inhabited the waterways in Iowa; however, successful nesting by this species has not been documented in Iowa since Europeans first settled in the region. The IDNR and multiple conservation partners initiated an osprey restoration program in the late 1990s. In 1998, osprey fledglings from Minnesota and Wisconsin were released along the Cedar River in Black Hawk County (IDNR 2006a) and in 2006 another release was performed at Wickiup Hill (IDNR 2006b), across the Cedar River from DAEC in Linn County. DAEC personnel report a recent nesting attempt by ospreys on DAEC's meteorological tower. DAEC has initiated discussions with IDNR concerning construction of an artificial nesting platform for the ospreys. The osprey, generally considered an indicator species for good water quality, is not a federal- or state-listed species in Iowa.

Section 3.1.3 describes the transmission lines/corridors built to connect DAEC to the transmission grid system. These lines are currently maintained by Alliant Energy, who maintains the vegetation (primarily the removal of fast-growing trees) within the transmission corridors once every five years (AE undated) to insure continued and safe dispersal of electricity through this system. In late 2008 or early 2009, the responsibility for maintenance will transition to ITC Midwest, the current owners of the transmission lines. The principle land use category of the area crossed by these transmission lines is agricultural.

2.5 THREATENED OR ENDANGERED SPECIES

No threatened or endangered species are known to occur on the DAEC property (AEC 1973) or within the adjacent reaches of the Cedar River (Helms 2003), although there are known occurrences within the counties associated with the facility and transmission lines. Table 2.5-1 indicates animal and plant species under federal and state protection known to occur in counties in which DAEC and its associated transmission lines are located. These include federally- or state-listed species, species proposed for federal listing, and candidates for federal listing. The transmission lines are located in Benton, Black Hawk, and Linn counties. Special status species reported in Table 2.5-1 as occurring in these counties were taken from county records maintained by the U.S. Fish and Wildlife Service (USFWS 2007a) and the Natural Areas Inventory of the Iowa Department of Natural Resources (IDNR 2007c).

Two plant species recorded in the counties associated with DAEC and its transmission corridors are federally-listed as threatened. These are discussed below, as well as two state-listed avian species, one of which was introduced on the DAEC site.

Prairie Bush Clover

The prairie bush clover (*Lespedeza leptostachya*) is a legume found only in the tallgrass prairie region of Iowa, Illinois, Minnesota and Wisconsin (USFWS 2000). Because of its restricted range, it is considered a midwestern endemic plant. Prairie bush clover has slender clover-like leaves, is between 9 and 18 inches tall, and has flowers loosely arranged on an open spike.

Prairie bush clover is listed as threatened by federal and state agencies (IDNR 2007c, USFWS 2007a). It thrives in mesic to dry prairie. The decline of this species was associated with the conversion of these natural prairies to cropland (through plowing) as well as overgrazing and herbicide application. It has been recorded in Linn County, Iowa (IDNR 2007c), but is not known to occur on the DAEC site.

Western Prairie Fringed Orchid

The western prairie fringed orchid (*Platanthera praeclara*) is a prairie perennial that produces a tall (up 47 inches) flower stalk with 20 to 40 flowers. These flowers attract hawkmoths (various species of *Sphingidae*), which feed nocturnally on nectar within these flowers and transfer pollen between flowers and plants. Western prairie fringed orchids occur west of the Mississippi River in Iowa, Kansas, Minnesota, Nebraska, North Dakota, and in Manitoba, Canada. They occur most often in mesic to wet, unplowed tallgrass prairies and meadows, but have occasionally been found in old fields and roadside ditches.

Western prairie fringed orchids are listed as threatened by federal and state agencies (IDNR 2007c, USFWS 2007a). The species has been recorded in Benton, Black Hawk, and Linn counties; however, these are historical records (all pre-1940) and not due to extant populations within these counties (USFWS 1996). There are no records of the western prairie fringed orchid on the DAEC site.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is a well-known large raptor with distinctive white head plumage that is distributed throughout the United States. Recently de-listed (USFWS 2007b), it remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald eagles are still listed as endangered by the state of Iowa (IDNR 2007c). Breeding bald eagles were considered extirpated from Iowa shortly after the turn of the century (IDNR 2006c). Nesting by eagles re-occurred in the 1970s and by 2006, nesting eagles were present in 75 Iowa counties. Bald eagles are reported as nesting in Benton, Black Hawk and Linn counties, but are not known to nest on or near the DAEC property.

Peregrine Falcon

Peregrine falcons (*Falco peregrinus*) were considered extirpated from the eastern United States, including Iowa, in the mid-1960s (IDNR 2006c), presumably due to pesticide (DDT) impacts. The population was classified as federally endangered and efforts were initiated to recover the species. Attempts to re-establish breeding peregrines in Iowa started in 1989 when young birds were released at urban “hacking sites” in various locations of the state. This method has continued since then and was successful in establishing low numbers (five to six pairs) of breeding peregrine falcons in Iowa. Peregrine falcons are no longer federally endangered but remain state-listed as endangered and are known to breed in Linn County. In 2002, in cooperation with Iowa’s Peregrine Falcon Restoration Project, eight young peregrines were released at a hacking station on DAEC property. This was attempted for only one year and the birds did not return to DAEC.

TABLE 2.5-1
PROTECTED SPECIES IN IOWA COUNTIES CONTAINING DUANE ARNOLD FACILITIES AND TRANSMISSION LINES

Scientific Name	Common Name	Federal Status[1]	State Status[1]	County[2]
Amphibians				
Ambystoma laterale	Blue-spotted salamander	-	E	Black Hawk, Linn
Necturus maculosus	Mudpuppy	-	T	Black Hawk
Notophthalmus viridescens	Central newt	-	T	Black Hawk, Linn
Birds				
Ammodramus henslowii	Henslow's sparrow	-	T	Linn
Buteo lineatus	Red-shouldered hawk	-	E	Benton, Black Hawk
Falco peregrinus	Peregrine falcon	-	E	Linn
Haliaeetus leucocephalus	Bald eagle	DL	E	Benton, Black Hawk, Linn
Fish				
Ammocrypta clara	Western sand darter	-	T	Black Hawk, Linn
Esox americanus	Grass pickerel	-	T	Linn
Etheostoma spectabile	Orangethroat darter	-	T	Linn
Lampetra appendix	American brook lamprey	-	T	Benton, Black Hawk, Linn
Moxostoma duquesnei	Black redhorse	-	T	Benton, Linn
Notropis heterolepis	Blacknose shiner	-	T	Benton, Linn
Notropis texanus	Weed shiner	-	E	Benton, Linn
Freshwater Mussels				
Alasmidonta viridis	Slippershell mussel	-	E	Linn
Anodontoides ferussacianus	Cylindrical papershell	-	T	Black Hawk, Linn
Lampsilis teres	Yellow sandshell	-	E	Linn
Lasmigona compressa	Creek heelsplitter	-	T	Linn
Strophitus undulates	Creeper	-	T	Linn
Tritogonia verrucosa	Pistolgrip	-	E	Linn
Venustaconcha ellipsiformis	Ellipse	-	E	Linn
Insects				
Euphydryas phaeton	Baltimore	-	T	Linn
Problema byssus	Byssus skipper	-	T	Linn
Mammals				
Perognathus flavescens	Plains pocket mouse	-	E	Benton, Black Hawk, Linn
Spilogale putorius	Spotted skunk	-	E	Black Hawk

TABLE 2.5-1 (CONTINUED) PROTECTED SPECIES IN IOWA COUNTIES CONTAINING DUANE ARNOLD FACILITIES AND TRANSMISSION LINES

Scientific Name	Common Name	Federal Status[1]	State Status[1]	County[2]
Plants				
Besseya bullii	Kitten tails	-	T	Benton, Black Hawk, Linn
Betula pumila	Bog birch	-	T	Black Hawk
Botrychium simplex	Little grape fern	-	T	Black Hawk, Linn
Chimaphilla umbellate	Prince's pine	-	T	Linn
Cornus canademsis	Bunchberry	-	T	Linn
Cypripedium reginae	Showy lady's slipper	-	T	Black Hawk
Dalea villosa	Silky prairie clover	-	E	Black Hawk
Decodon verticillata	Waterwillow	-	E	Black Hawk
Dichanthelium borealis	Northern panic grass	-	E	Linn
Equisetum sylvaticum	Woodland horsetail	-	T	Black Hawk, Linn
Gaylussacia baccata	Black huckleberry	-	T	Linn
Hypericum boreale	Northern St. Johns wort	-	E	Linn
Ilex verticillata	Winterberry	-	E	Linn
Lechea intermedia	Narrowleaf pinweed	-	T	Benton
Lespedeza leptostachya	Prairie bush clover	T	T	Linn
Menyanthes trifoliate	Buckbean	-	T	Linn
Mimulus glabratus	Yellow monkey flower	-	T	Linn
Oenothera perennis	Small sundrops	-	T	Linn
Opuntia macrorhiza	Prickly-pear	-	E	Linn
Platanthera flava	Tubercled orchid	-	E	Linn
Platanthera praeclara	Western prairie fringed orchid	T	T	Benton, Black Hawk, Linn
Platanthera psycoides	Purple fringed orchid	-	T	Linn
Polygala incarnata	Pink milkwort	-	T	Black Hawk, Linn
Polygala polygama	Racemed willowort	-	E	Linn
Salix pedicellaris	Bog willow	-	T	Benton, Black Hawk
Spiranthes ovalis	Oval ladies-tresses	-	T	Linn
Xyris torta	Yellow-eyed grass	-	E	Benton, Linn
Reptiles				
Clemmys insculpta	Wood turtle	-	E	Benton, Black Hawk,
Crotalus viridis	Prairie rattle snake	-	E	Benton
Emydoidea blandingii	Blandings turtle	-	T	Black Hawk, Linn

TABLE 2.5-1 (CONTINUED)
PROTECTED SPECIES IN IOWA COUNTIES CONTAINING DUANE ARNOLD FACILITIES AND TRANSMISSION LINES

Scientific Name	Common Name	Federal Status[1]	State Status[1]	County[2]
Reptiles (continued)				
Terrapene ornate	Ornate box turtle	-	T	Benton, Black Hawk, Linn
Snails				
Vertigo meramecensis	Bluff vertigo	-	T	Linn

1 E = Endangered, T = Threatened, DL = de-listed (IDNR 2007c, USFWS 2007a).

2 DAEC is located in Linn County; transmission line corridors associated with this facility are located in Linn, Benton, and Black Hawk Counties, Iowa.

2.6 DEMOGRAPHY

2.6.1 REGIONAL DEMOGRAPHY

The Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) presents a population characterization method that is based on two factors: “sparseness” and “proximity” (NRC 1996e). “Sparseness” measures population density and city size within 20 miles of a nuclear power plant and categorizes the demographic information as follows:

Demographic Categories Based on Sparseness

Sparseness		Category
Most sparse	1.	Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles
	2.	40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles
	3.	60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles
Least sparse	4.	Greater than or equal to 120 persons per square mile within 20 miles

Source: NRC 1996e.

“Proximity” measures population density and city size within 50 miles of a nuclear power plant and categorizes the demographic information as follows:

Demographic Categories Based on Proximity

Proximity		Category
Not in close proximity	1.	No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles
	2.	No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles
	3.	One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles
In close proximity	4.	Greater than or equal to 190 persons per square mile within 50 miles

Source: NRC 1996e.

The GEIS then uses the following matrix to rank the population category as low, medium, or high.

GEIS Sparseness and Proximity Matrix

		Proximity			
		1	**2**	**3**	**4**
Sparseness	1	1.1	1.2	1.3	1.4
	2	2.1	2.2	2.3	2.4
	3	3.1	3.2	3.3	3.4
	4	4.1	4.2	4.3	4.4

Low Population Area | Medium Population Area | High Population Area

Source: NRC 1996e.

FPL Energy Duane Arnold, LLC (FPL-DA) used Year 2000 census data from the U.S. Census Bureau (USCB) (TtNUS 2007a) with geographic information system software (ArcGIS®) to determine most demographic characteristics in the DAEC vicinity. The calculations (TtNUS 2007a) determined that 210,081 people live within 20 miles of DAEC, producing a population density of 167 persons per square mile. Applying the GEIS sparseness measures results in a least sparse category, Category 4 (greater than or equal to 120 persons per square mile within 20 miles).

To determine the proximity category, FPL-DA determined that 621,461 people live within 50 miles of DAEC, which equates to a population density of 79 persons per square mile (TtNUS 2007a). Applying the GEIS proximity measures, DAEC is classified as Category 3 (one or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles). Therefore, according to the GEIS sparseness and proximity matrix, the DAEC ranks of Category 4 sparseness, and Category 3 proximity result in the conclusion that DAEC is located in a high population area.

All or parts of 22 counties and 3 Metropolitan Statistical Areas (MSAs) are located within 50 miles of DAEC (Figure 2.1-2). The MSAs are Cedar Rapids, Waterloo-Cedar Falls, and Iowa City (USCB 2003a).

DAEC is located in the Cedar Rapids MSA. The Cedar Rapids MSA had a 2000 population of 237,230. From 1990 to 2000, the population of the Cedar Rapids MSA increased from 210,640 to 237,230, an increase of 12.6 percent. The populations in other MSAs within 50 miles of DAEC also increased between 1990 and 2000. The population of the Waterloo-Cedar Falls MSA increased from 158,640 to 163,706, an increase of 3.2 percent. The population of the Iowa City MSA increased from 115,731 to 131,676, an increase of 13.8 percent (USCB 2003a).

The town of Palo (2 miles south-southeast of the site) is the nearest concentration of population to DAEC, with a 2000 population of 614. Cedar Rapids (5.7 miles southeast), Iowa City (32 miles southeast), and Waterloo (34 miles northwest), are the largest population centers within the 50-mile radius, with 2000 populations of: 120,758; 68,747; and 62,220, respectively (USCB 2003b).

Because approximately 83.7 percent of employees at DAEC reside in Linn and Benton Counties, Iowa, they are the counties with the greatest potential to be socioeconomically affected by license renewal at DAEC (see Section 3.4). Table 2.6-1 shows population counts and growth rates for these counties. Values for the city of Cedar Rapids are provided to illustrate the fluctuations in population in the urban portion of Linn County. The values for the state of Iowa are also provided for comparison.

From 1970 to 1980, the state and Linn and Benton Counties experienced modest growth rates, while the population in the city of Cedar Rapids declined slightly. From 1980 to 1990, the two counties, the city of Cedar Rapids, and the state experienced negative growth rates. From 1990 to 2000, the two counties, the city of Cedar Rapids, and the state have experienced positive growth rates. During the 1990 to 2000 period, the growth rates in Cedar Rapids and the two counties were more than double that of the state. Overall, Linn and Benton Counties, and the state have experienced positive growth rates and are projected to continue to grow during the license renewal period.

2.6.2 MINORITY AND LOW-INCOME POPULATIONS

The U.S. Nuclear Regulatory Commission (NRC) performed environmental justice analyses for previous license renewal applications and concluded that a 50-mile radius could reasonably be expected to contain potential environmental impact sites and that the encompassing state was appropriate as the geographic area for comparative analysis. FPL-DA has adopted this approach for identifying the DAEC minority and low-income populations that could be affected by DAEC operations.

FPL-DA used ArcGIS® geographic information system software to combine USCB TIGER line data with USCB 2000 census data to determine the minority characteristics by block group. FPL-DA included all block groups if any part of their area lay within 50 miles of DAEC. The 50-mile radius includes 512 block groups (Table 2.6-2).

2.6.2.1 Minority Populations

The NRC Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues defines a “minority” population as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; black races; all other single races; multi-racial; and Hispanic ethnicity (NRC 2004, Appendix D). The guidance indicates that a minority population exists if either of the following two conditions exists:

- The minority population in the census block group or environmental impact site exceeds 50 percent.
- The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for comparative analysis.

NRC guidance calls for use of the most recent USCB decennial census data. FPL-DA used 2000 census data from the USCB website (USCB 2000a and 2000b) to determine the percentage of the total population in Iowa of each minority category, and to identify minority populations within 50 miles of DAEC.

FPL-DA divided USCB population numbers for each minority population within each block group by the total population of that block group to obtain the percent of the block group's population represented by each minority. For each of the 512 block groups within 50 miles of DAEC, FPL-DA calculated the percent of the population in each minority category and compared the result to the corresponding geographic area's minority threshold percentages to determine whether minority populations exist (TtNUS 2007b). FPL-DA defines the geographic area for DAEC as the state of Iowa.

USCB data (USCB 2000a) for Iowa characterizes 0.31 percent of the population as American Indian or Alaskan Native; 1.25 percent Asian; 0.03 percent Native Hawaiian or other Pacific Islander; 2.11 percent black races; 1.28 percent all other single minorities; 1.09 percent multi-racial; 6.07 percent aggregate of minority races; and 2.82 percent Hispanic ethnicity.

Table 2.6-2 presents the numbers of block groups in each county in the 50-mile radius that exceed the threshold for minority populations. Figures 2.6-1 through 2.6-4 locate the minority block groups within the 50-mile radius.

Fourteen census blocks within the 50-mile radius have black races populations that meet the NRC criteria for a minority population. These block groups, shown in Figure 2.6-1, are concentrated in urban areas (Waterloo and Cedar Rapids) 10 or more miles from the DAEC site.

Two census blocks within the 50-mile radius in Tama County have American Indian or Alaskan Native populations that meet the NRC criteria for a minority population (Figure 2.6-2). The Meskwaki Settlement of the Sac & Fox Tribe of the Mississippi is located in this county (EDA 2007).

Twenty-three census blocks within the 50-mile radius have Aggregate Minority populations that meet the NRC criteria for a minority population. These census blocks are shown in Figure 2.6-3.

Two census blocks within the 50-mile radius in Muscatine County have Hispanic Ethnicity populations that meet the NRC criteria for a minority population. These block

Two census blocks within the 50-mile radius in Muscatine County have Hispanic Ethnicity populations that meet the NRC criteria for a minority population. These block groups, shown in Figure 2.6-4, are near the town of West Liberty approximately 40 miles southwest of the DAEC site.

2.6.2.2 Low-Income Populations

NRC guidance defines low-income based on statistical poverty thresholds (NRC 2004, Appendix D). FPL-DA divided USCB low-income households in each census block group by the total households for that block group to obtain the percentage of low-income households per block group. USCB data (USCB 2000b) characterize 9.32 percent of Iowa as low-income households. A low-income population is considered to be present if:

1. The low-income population in the census block group or the environmental impact site exceeds 50 percent.

2. The percentage of households below the poverty level in an environmental impact area is significantly greater (typically at least 20 percentage points) than the low-income population percentage in the geographic area chosen for comparative analysis.

Table 2.6-2 identifies the low-income block groups in the region of interest. Figure 2.6-5 locates the low-income block groups.

Fifteen census blocks within the 50-mile radius have low-income households that meet the NRC criteria. These block groups, shown in Figure 2.6-5, are concentrated in urban areas (Waterloo and Iowa City) 30 or more miles from the DAEC site.

TABLE 2.6-1
DECENNIAL POPULATIONS, PROJECTIONS, AND GROWTH RATES

	Linn County		Benton County		Cedar Rapids		Iowa	
Year	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
1970	163,213	NA	22,885	NA	110,642	NA	2,825,368	NA
1980	169,775	4.0%	23,649	3.3%	110,243	-0.4%	2,913,808	3.1%
1990	168,767	-0.6%	22,429	-5.2%	108,772	-1.3%	2,776,831	-4.7%
2000	191,701	13.6%	25,308	12.8%	120,758	11.1%	2,926,324	5.4%
2006[a]	201,853	5.3%	26,962	6.5%	124,417	2.5%	2,982,085	1.9%
2010	211,516	10.3%	28,513	12.7%	NA	NA	3,035,321	1.8%
2020	237,116	12.1%	31,593	10.8%	NA	NA	3,181,466	4.8%
2030	265,098	11.8%	34,990	10.8%	NA	NA	3,360,401	5.6%

a. Growth for the 2000-2006 interval. All other growth rates are based on decennial populations.

Source: USCB 1990; USCB 2003b; USCB 2007a, 2007b; State Library of Iowa 2006a

TABLE 2.6-2
BLOCK GROUPS WITHIN 50 MILES OF DAEC WITH MINORITY OR LOW-INCOME POPULATIONS MORE THAN 20 PERCENT OVER THE STATE OR GREATER THAN 50 PERCENT

County Name	Number of Block Groups	Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate	Hispanic	Low-Income Households
Benton	21	0	0	0	0	0	0	0	0	0
Black Hawk	100	12	0	0	0	0	0	13	0	8
Bremer	10	0	0	0	0	0	0	0	0	0
Buchanan	19	0	0	0	0	0	0	0	0	0
Cedar	20	0	0	0	0	0	0	0	0	0
Clayton	6	0	0	0	0	0	0	0	0	0
Clinton	4	0	0	0	0	0	0	0	0	0
Delaware	18	0	0	0	0	0	0	0	0	0
Dubuque	15	0	0	0	0	0	0	0	0	0
Fayette	14	0	0	0	0	0	0	0	0	0
Grundy	5	0	0	0	0	0	0	0	0	0
Iowa	14	0	0	0	0	0	0	0	0	0
Jackson	3	0	0	0	0	0	0	0	0	0
Johnson	59	0	0	0	0	0	0	1	0	7
Jones	19	0	0	0	0	0	0	0	0	0
Keokuk	7	0	0	0	0	0	0	0	0	0
Linn	133	2	0	0	0	0	0	5	0	0
Louisa	1	0	0	0	0	0	0	0	0	0

TABLE 2.6-2 (CONTINUED)
BLOCK GROUPS WITHIN 50 MILES OF DAEC WITH MINORITY OR LOW-INCOME POPULATIONS MORE THAN 20 PERCENT OVER THE STATE OR GREATER THAN 50 PERCENT

County Name	Number of Block Groups	Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate	Hispanic	Low-Income Households
Muscatine	7	0	0	0	0	0	0	2	2	0
Poweshiek	8	0	0	0	0	0	0	0	0	0
Tama	21	0	2	0	0	0	0	2	0	0
Washington	8	0	0	0	0	0	0	0	0	0
TOTALS:	**512**	**14**	**2**	**0**	**0**	**0**	**0**	**23**	**2**	**15**

	Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate	Hispanic	Low-Income Households
Iowa Percentages	**2.11**	**0.31**	**1.25**	**0.03**	**1.28**	**1.09**	**6.07**	**2.82**	**9.32**

Highlighted counties are completely contained within the 50-mile radius.
Source: TtNUS 2007b

FIGURE 2.6-1 BLACK MINORITY POPULATION

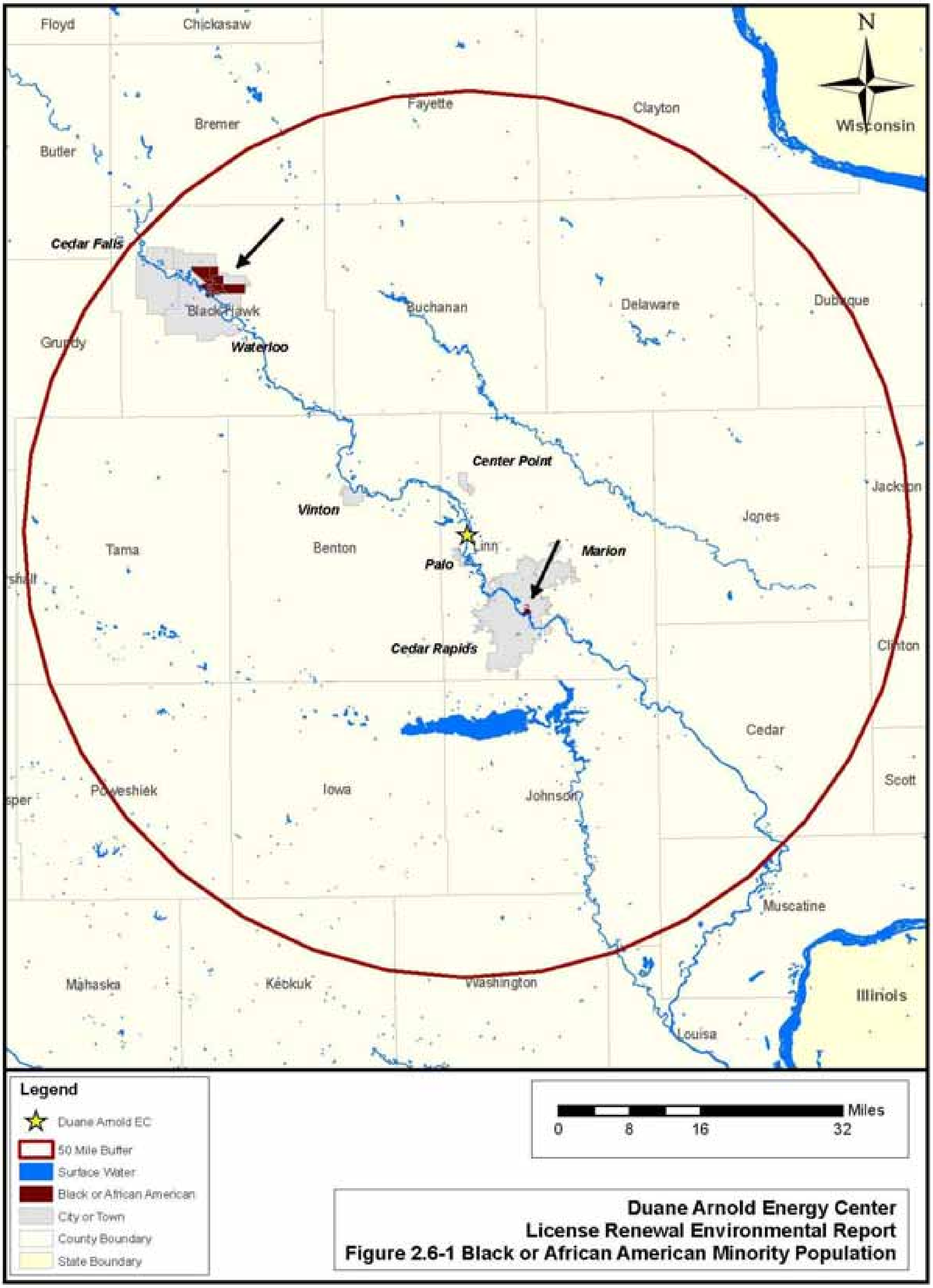


FIGURE 2.6-2 AMERICAN INDIAN OR ALASKAN NATIVE MINORITY POPULATION

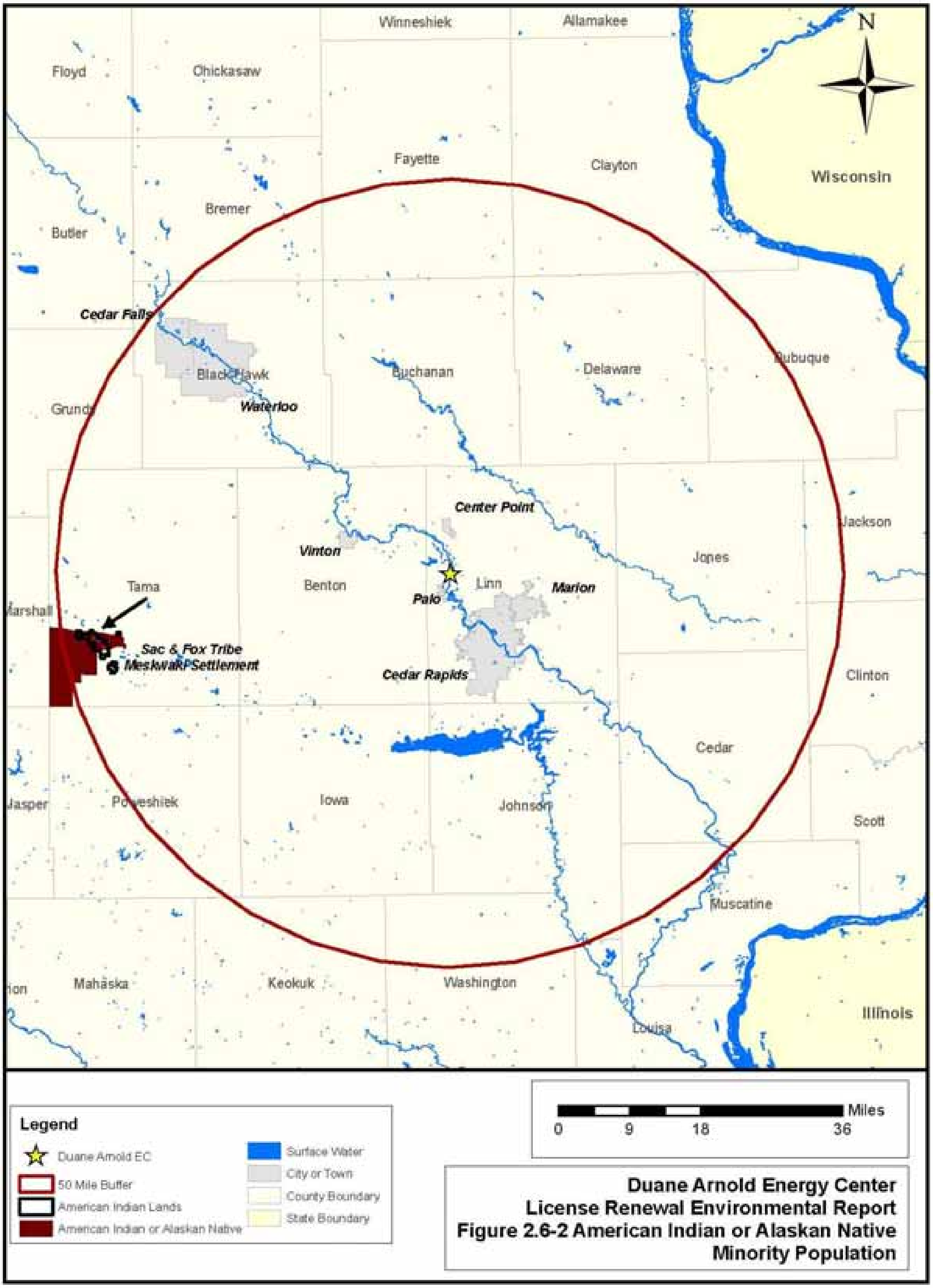


FIGURE 2.6-3 AGGREGATE MINORITY POPULATION

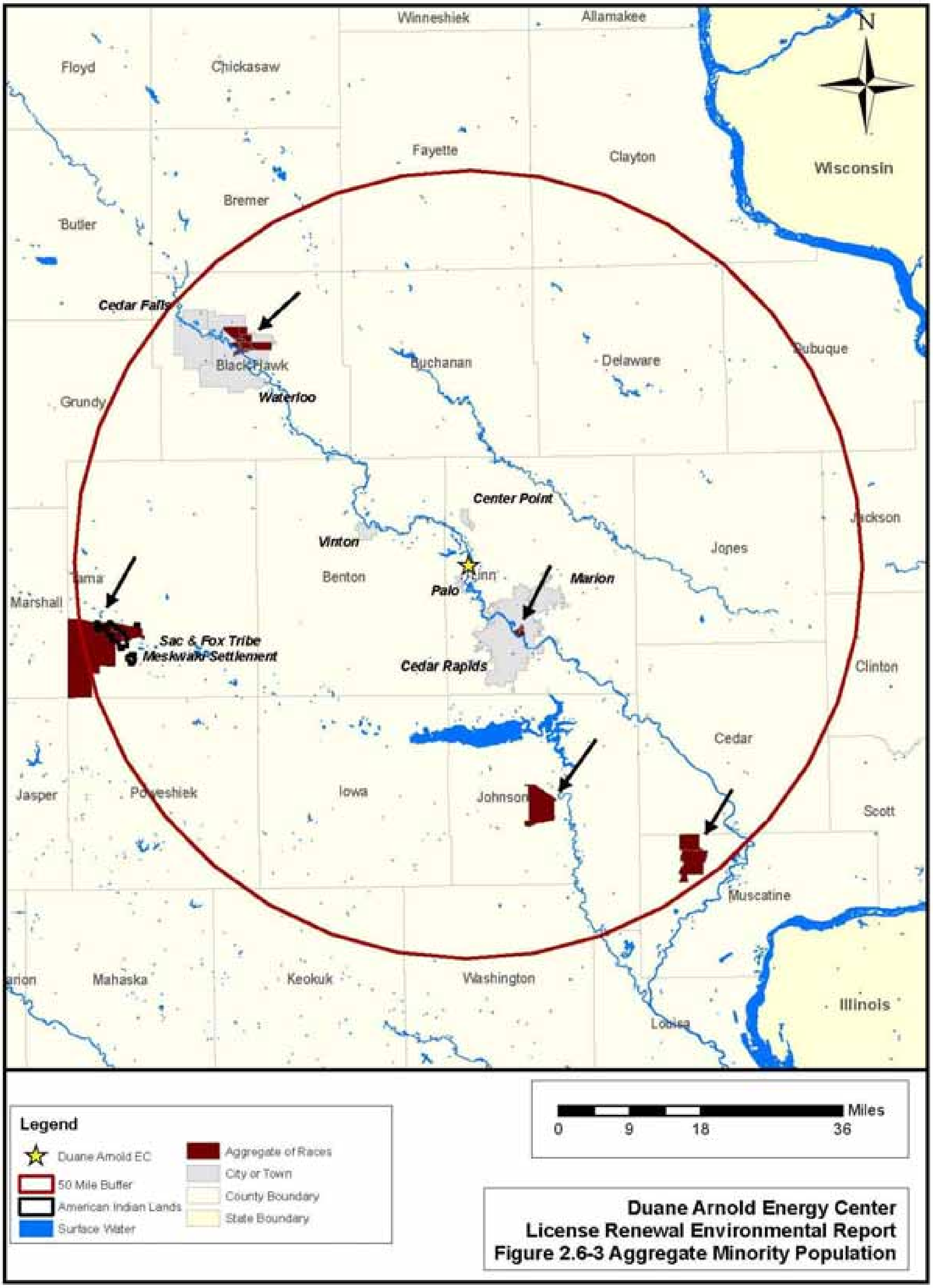


FIGURE 2.6-4 HISPANIC ETHNICITY POPULATION

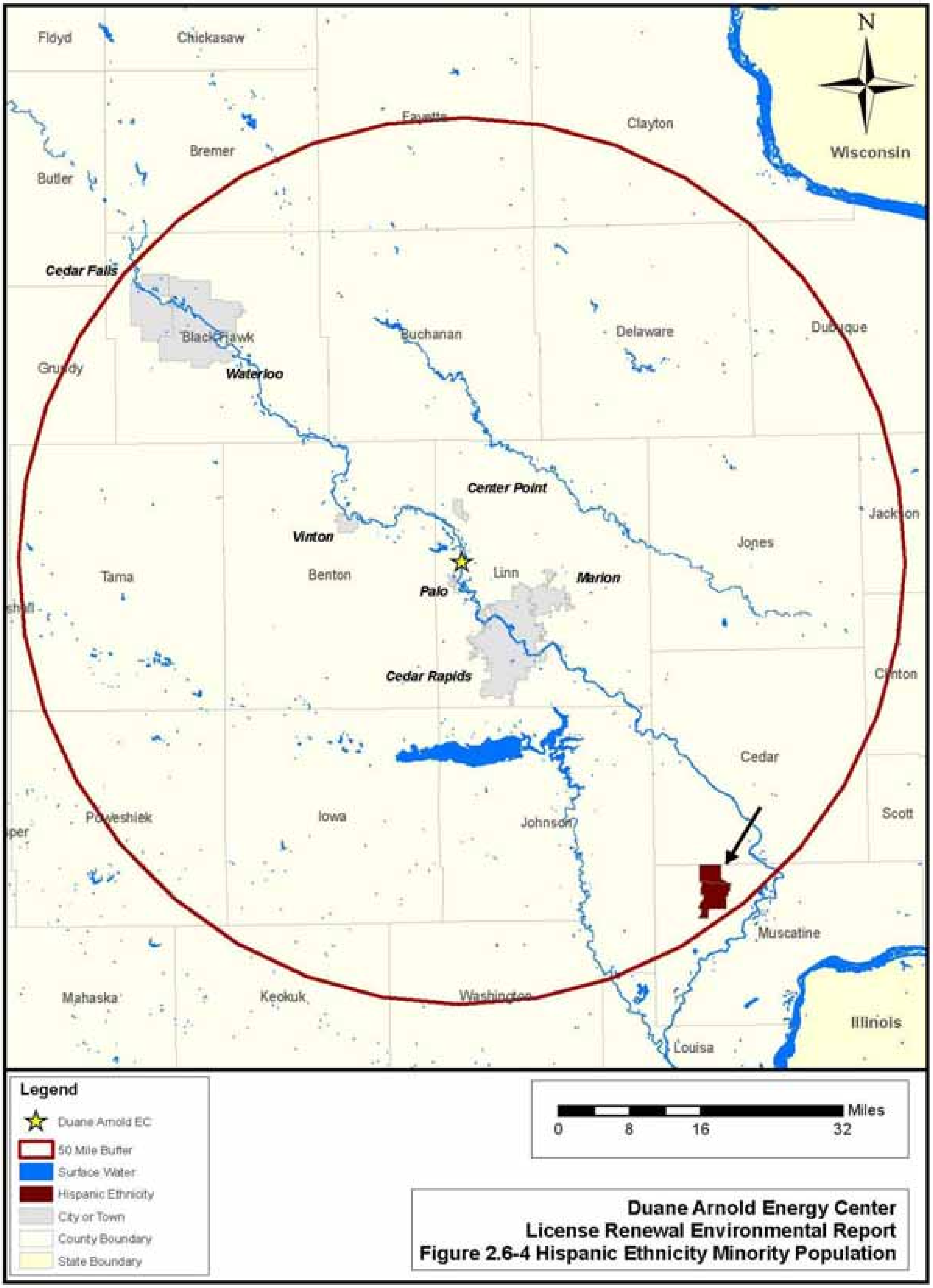
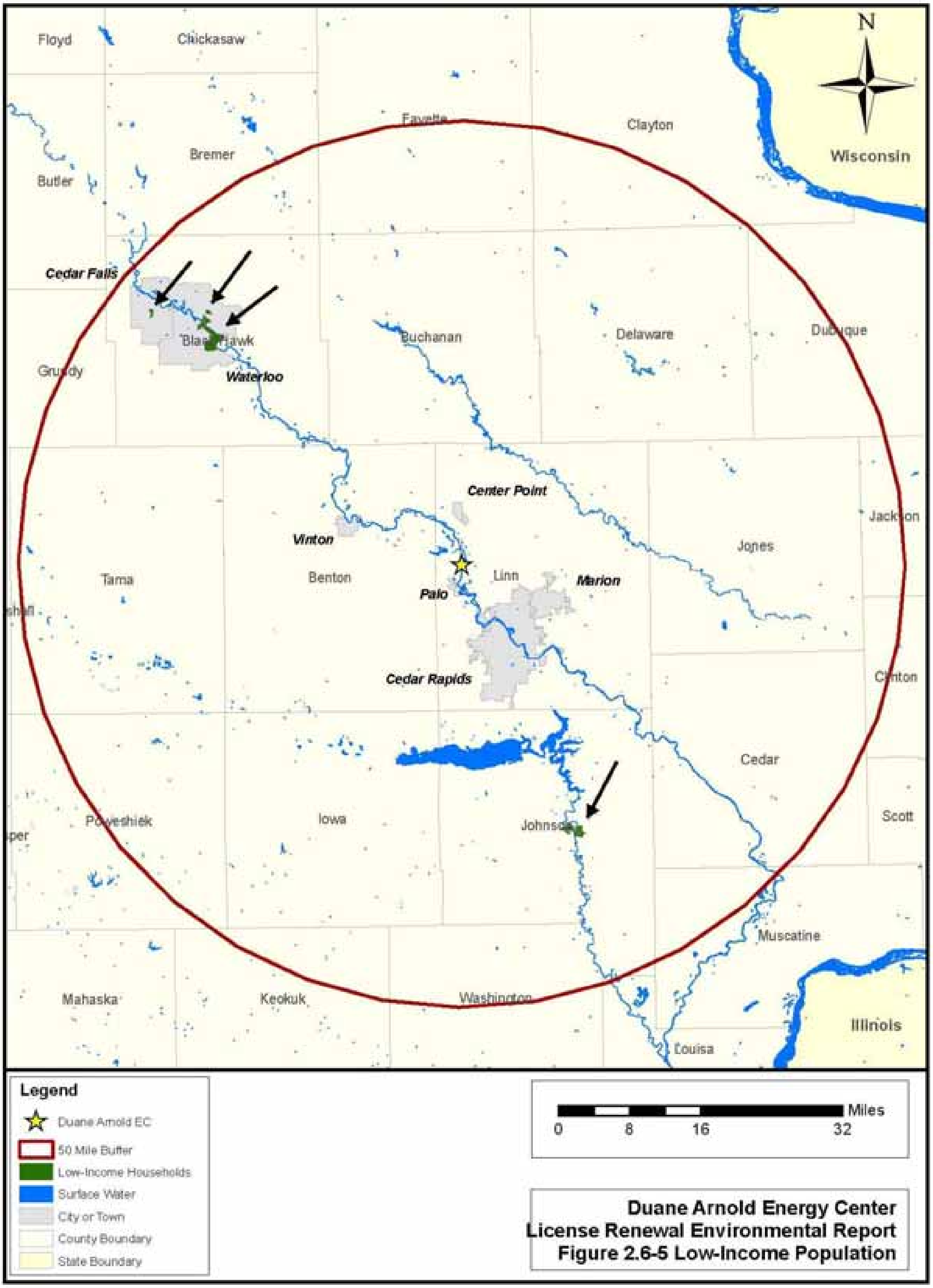


FIGURE 2.6-5 LOW-INCOME POPULATION



2.7 TAXES

The owners of DAEC pay annual property taxes to Linn County. Linn County distributes them to other taxing authorities in the county. Table 2.7-1 presents the tax payments for fiscal years 2003 through 2007.

Each year, Linn County collects property taxes for its operations and other taxing authorities within 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 tax revenue collected to the townships, school districts, cities, and other taxing authorities in the county (Linn County 2006a and 2006b). From fiscal years 2003 through 2006, Linn County collected approximately $213 to $245 million annually in property taxes (see Table 2.7-2). Of this, DAEC's property tax payments represented 0.26 to 0.43 percent of the total property tax revenues collected in Linn County and the approximately $1.1 million taxes it paid in 2007 are expected to be less than one-half of a percent of the total based on the yearly average increase in tax collections from 2002 to 2006. Of the monies collected from 2002 to 2006, Linn County retained $35 to $41 million dollars each year for its operations. Of this, DAEC's Linn County tax payments were approximately $125,000 to $228,000,or less than 1 percent of Linn County's total operational costs. As shown in Table 2.7-1, more than 50 percent of DAEC tax payments go to Cedar Rapids Community School District. The Cedar Rapids Community School District operates 34 schools and has an enrollment of approximately 17,800 students (CRCS 2005a). The District had expenditures of approximately $169 million during the 2004-2005 school year (CRCS 2005b). DAEC property tax payments to the District would represent a small fraction of the operating budget.

With respect to deregulation, the 1998 Iowa Legislature established the "Deregulation and Restructuring of the Electric Utility Industry Study Committee" to review restructuring activities and experiences in other states. 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. 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.

TABLE 2.7-1
DUANE ARNOLD ENERGY CENTER TAX PAYMENT INFORMATION FOR FISCAL YEARS 2003 – 2007

	2003	2004	2005	2006	2007
Cedar Rapids Community Schools	$448,520	$362,854	$356,174	$607,007	$644,825
Linn County	$157,059	$127,061	$124,728	$228,219	$254,401
Rural Services Basic	$104,810	$84,762	$83,237	$146,603	$159,676
Kirkwood College	$19,027	$15,393	$15,115	$25,821	$29,603
Fire District	$17,280	$13,979	$13,728	$23,921	$25,958
County Assessor	$6,760	$5,469	$5,374	$9,736	$11,673
Fayette Township	$3,927	$3,177	$3,125	$4,816	$5,235
Other	$2,165	$1,751	$1,683	$3,064	$4,144
TOTAL	$759,548	$614,446	$603,164	$1,049,187	$1,135,515

TABLE 2.7-2
DUANE ARNOLD ENERGY CENTER TAX PAYMENT COMPARISON WITH LOCAL TAX REVENUES

Fiscal Year	Total Local Property Tax Revenues (all Linn County taxing authorities)[1]	DAEC Total Local Property Taxes Paid	Percent of Total Local Property Tax Revenues	Linn County Property Tax Revenues[1]	DAEC Linn County Property Taxes Paid	Percent of Linn County Property Tax Revenues
2003	$212,849,000	$759,546	0.36	$34,631,000	$157,059	0.45
2004	$220,780,000	$614,476	0.28	$36,019,000	$127,061	0.35
2005	$235,967,000	$603,164	0.26	$38,574,000	$124,728	0.32
2006	$245,310,000	$1,049,187	0.43	$40,720,000	$228,219	0.56

1. Source: Linn County 2006b

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2.8 LAND USE

This section focuses on Linn and Benton Counties because the majority of the permanent DAEC workforce (approximately 83.7 percent) lives in these counties (see Section 3.4) and because DAEC pays property taxes in Linn County.

DAEC is located in Linn County, 2.5 miles from the Town of Palo which has an economy based on small retail and service industry businesses, and 5.7 miles from the outer boundary of the City of Cedar Rapids. As stated in Section 2.1, the DAEC property is a 500-acre tract, of which a small portion is used for power production. The non-industrial portion of the DAEC property is leased for farming. DAEC's nearest neighbors are a dairy product distribution center, a horticulture nursery, and a strawberry farm.

Linn County

Linn County is 717 square miles (458,180 acres) (USCB 2003b, Linn County 2003) and had a 2000 population of 191,701 (USCB 2003b), with the largest concentration in the Cedar Rapids metropolitan area. Linn County is primarily rural outside of the Cedar Rapids metropolitan area. Cedar Rapids had a 2000 population of 120,758 and a total land area of approximately 64 square miles (USCB 2003b). Table 2.6-1 presents the historical population of Linn County and Cedar Rapids.

From 1990 to 2000, Linn County's population grew 14 percent, while the population of the state of Iowa grew 5.4 percent. Over the same period, the number of housing units in Linn County increased by 17.8 percent (12,194 units), while the total number of units in the state increased by 7.8 percent (USCB 2003b). As shown in Table 2.8-1, more than one-half of the housing unit increases (6,767) were in the City of Cedar Rapids. The City of Marion, which is in the Cedar Rapids metropolitan area, gained 2,970 housing units from 1990 to 2000 (USCB 2003b). The Cities of Cedar Rapids and Marion accounted for nearly 80 percent of the housing unit growth, indicating that the pattern of development continued to be within incorporated areas. Furthermore, Linn County reported that single family housing permits for unincorporated areas averaged 114 permits per year from 1993 to 1998 and that zoning changes were having the effect of discouraging growth in the unincorporated areas of the county (Linn County 2003).

The cities in Linn County comprise 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).

In 1973, before DAEC began operations, the surrounding 10-mile area with the exception of the portion of the City of Cedar Rapids within the 10-mile radius was characterized as 90 percent farmland (AEC 1973). As indicated above, the current land use pattern is similar. Undeveloped land represents more than 84 percent of the land outside of incorporated areas. Of the remaining 16 percent of land, some of it is also undeveloped (i.e., public land such as parks and land that cannot be developed because it lies in critical natural resource areas).

Linn County land use planning addresses the nature of the county, which is rural interspersed with metropolitan areas. The Linn County Regional Planning Commission coordinates land use planning, zoning, transportation improvements, water and sewer systems, and other issues among the municipalities and Linn County 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). DAEC lies outside of the Cedar Rapids metropolitan area.

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 guide for land use decision-making through the year 2020. The Linn County Rural Land Use Plan Map shows DAEC in an agricultural area near a Critical Natural Resource Area, which lies along the Cedar River (Linn County 2003 and 2006c).

Benton County

Benton is a rural county which covers 716 square miles (USCB 2003b) and has a population density of 35 persons per square mile. Farm acreage totals approximately 400,000 acres (USDA 2002), about 87 percent of the total land area of the county. In 2002, the county had approximately 1,200 farms with an average size of about 200 acres (USDA 2002).

The County has several small towns and its county seat, the City of Vinton, has a population of approximately 5,100 (USCB 2003b). The Benton County Development Group works with the county and municipalities to promote Benton County for business development. The County has industrial parks in Urbana and Van Horne (BDG 2007). Urbana and Van Horne had 2000 populations of 1,019 and 716, respectively (USCB 2003b).

From 1990 to 2000, Benton County’s population grew 13 percent, while the population of the state of Iowa grew 5.4 percent. Over the same period, 1990 to 2000, the number of housing units in Benton County increased by 13.7 percent, while the total number of units in the state increased by 7.8 percent (USCB 2003b). Table 2.6-1 presents the historical population of Benton County.

Benton County has a Land Preservation and Use Plan that provides the land use policy for the unincorporated areas of the county. The plan ensures the protection and preservation of agricultural land and other limited natural resources, while providing for growth in those areas where it would be compatible with existing land uses and public facilities and services 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).

TABLE 2.8.1
HOUSING TRENDS, 1990 TO 2005, IN LINN AND BENTON COUNTIES, CITY OF CEDAR RAPIDS, AND THE STATE OF IOWA

	Linn County	Cedar Rapids	Benton County	Iowa
Housing Units 1990	68,357	45,472	9,125	1,143,666
Housing Units 2000	80,551	52,240	10,377	1,232,511
Percent Change, 1990 to 2000	17.8%	14.9%	13.7%	7.8%
Housing Units 2005	89,570	Not available	10,922	1,306,943
Percent Change, 2000 to 2005	11.2%	Not applicable	5.3%	6.0%

Source: USCB 2003b; State Library of Iowa 2006b

2.9 SOCIAL SERVICES AND PUBLIC FACILITIES

2.9.1 PUBLIC WATER SUPPLY

This section focuses on Linn and Benton Counties because the majority of the permanent DAEC workforce (approximately 83.7 percent) lives in these counties (see Section 3.4). The public water supply systems of Linn and Benton Counties are listed in Table 2.9-1 along with their water supply sources and the approximate size of the population being served. All of the systems have groundwater as their sources. However, some of the systems have as their primary source groundwater that is under the influence of surface water. Table 2.9-2 lists the maximum capacity and average daily use of the larger public water supply systems, those serving a population of more than 1,000 persons.

The largest water supply system in the two counties, the Cedar Rapids Water Department, which serves a population of approximately 122,633, has groundwater under the influence of surface water as its source (EPA 2007a). The Cedar Rapids Water Department 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 4 well fields with a total of 4 collector wells and 45 vertical wells. Peak flow is 50 mgd with an average of 35 mgd. The system has a design capacity of 65 mgd. Local industries use 75 percent of the water and the remaining 25 percent is used by residential, commercial, and municipal customers (CRWD 2005, CRWD undated).

2.9.2 TRANSPORTATION

The local road system is shown on Figure 2.1-1. DAEC is accessed by DAEC Road, which intersects with a road that has two names. North of the intersection, the road is called McClintock Road. South of the intersection, the road is called Power Plant Road. McClintock/Power Plant Road forms a U and terminates in two locations on Palo Marsh Road/County Road W36. Palo Marsh Road/County Road W36 links Interstate 380 to the north and Palo to the south. County Road W36 continues southeast of Palo and terminates with an intersection with Interstate 380 in the center of Cedar Rapids.

Employees commuting from Cedar Rapids could take County Road W36 as described above or take County Road E36 (also known as Blairs Ferry Road) which intersects with Palo Marsh Road/County Road W36. County Road E36 has an interchange with Interstate 380 at the northern edge of Cedar Rapids. Employees commuting from the north, such as Center Point, would travel south on County Road W36 and those coming from Palo would travel north on Palo Marsh Road/County Road W36. Employees from the west or southwest would travel to County Road E36 which then 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.

Traffic counts are not available for the roads described above except for Interstate 380 at the interchanges with County Road E36 (Blairs Ferry Road,) and County Road W36 (F Avenue), both in Cedar Rapids. Annual average daily traffic counts were 28,800 and 24,100 at the Blairs Ferry Road and F Avenue interchanges, respectively (IDOT 2006).

Level of Service (LOS) data is available only for Interstate 380 in the northern Cedar Rapids metropolitan area and at the Blairs Ferry Road interchange. LOS is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists. Traffic congestion conditions are rated as A through F and are designated as follows:

Level of Service	Conditions
A	Free flow of the traffic stream; users are unaffected by the presence of others.
B	Stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished.
C	Stable flow that marks the beginning of the range of flow in which the operation of individual users is significantly affected by interactions with the traffic stream.
D	High-density, stable flow in which speed and freedom to maneuver are severely restricted; small increases in traffic will generally cause operational problems.
E	Operating conditions at or near capacity level causing low but uniform speeds and extremely difficult maneuvering that is accomplished by forcing another vehicle to give way; small increases in flow or minor perturbations will cause breakdowns.
F	Defines forced or breakdown flow that occurs wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. This situation causes the formation of queues characterized by stop-and-go waves and extreme instability.

The LOS for Interstate 380 in the northern Cedar Rapids metropolitan area is C and at the Blairs Ferry Road interchange the LOS is D.

The area's long-range transportation plans adopted by the Linn County Regional Planning Commission include improvements to Interstate 380 and Blairs Ferry Road. The planning area does not extend beyond the Cedar Rapids metropolitan area. DAEC is located outside of the planning area. (LCRPC 2005)

Benton County does not have a transportation plan.

TABLE 2.9-1
PUBLIC WATER SUPPLY SYSTEMS IN LINN AND BENTON COUNTIES

Public Community Water System	Approximate Population Served	Primary Source Type
Linn County		
ABBE Center for Community Care	160	Groundwater
Alburnett Water Supply	559	Groundwater
ARC Cedar Terrace	483	Purchased groundwater under influence of surface water
ARC Marion Village	1,220	Purchased groundwater
Bertram Water Supply	263	Groundwater
Big Creek Bluffs	80	Groundwater
Blairs Ferry Manor	75	Groundwater
Brittany Estates Homeowners Association	105	Groundwater
Carlton Mobile Home Court	85	Groundwater
Cedar Rapids Water Department	122,633	Groundwater under influence of surface water
Center Point Water Supply	2,007	Groundwater
Central City Water Supply	1,157	Groundwater
Chestnut Ridge	50	Groundwater
Coggon Water Department	745	Groundwater
Cono Christian School	100	Groundwater
Country Estates	126	Purchased groundwater under the influence of surface water
Country Manor Estates	228	Groundwater
Crestwood Acres	142	Groundwater
D & M Addition	80	Groundwater
Deer Ridge Homeowners Water Association	94	Groundwater
Ely Water Supply	1,149	Groundwater
Fairfax Water Supply	1,662	Groundwater
Fairview Trailer Court	70	Groundwater
Four Oaks	60	Groundwater
Gaddis Estates Homeowners Association	30	Groundwater
Glenbrook Cove Area	233	Purchased groundwater under the influence of surface water
Glenn Oaks Addition	88	Groundwater
Hiawatha Water Department	6,480	Groundwater
Hide-A-Way Manor	82	Groundwater

TABLE 2.9.1
PUBLIC WATER SUPPLY SYSTEMS IN LINN AND BENTON COUNTIES (CONTINUED)

Public Community Water System	Approximate Population Served	Primary Source Type
Lisbon Water Supply	1,898	Groundwater
Marion Municipal Water Department	25,984	Groundwater
Meadow Knolls Addition	68	Groundwater
Midway Water and Lighting	72	Groundwater
Mount Vernon Water Supply	4,171	Groundwater
Oak Valley	154	Groundwater
ORR Addition	40	Groundwater
Pleasant Creek Estates – Palo	45	Groundwater
Prairieburg Municipal Water Supply	175	Groundwater
Spring Green	52	Groundwater
Springville Water Supply	1,101	Groundwater
Twin Knolls Fourth/Fifth Addition	144	Groundwater
Twin Knolls Sixth Addition	45	Groundwater
Vern Acres (Oliphant Addition)	150	Groundwater
Vernon Heights Mobile Home Court	120	Groundwater
Walker Water Works	754	Groundwater
West Post Estates Addition	93	Groundwater
Windy Ridge Well Association	45	Groundwater
Benton County		
Atkins Municipal Water Works	1,297	Groundwater
Belle Plaine Water Department	2,878	Groundwater
Blairstown Water Supply	682	Groundwater
Clover Ridge Subdivision	432	Groundwater
Garrison Water Supply	413	Groundwater
Keystone Water Supply	687	Groundwater
Mount Auburn Water Supply	160	Groundwater
Newhall Water Supply	886	Groundwater
Norway City Water Supply	601	Purchased groundwater under the influence of surface water
Poweshiek Water Association	2,000	Purchased groundwater under the influence of surface water
Shellsburg Water Supply	938	Groundwater
Terry Water Association	46	Groundwater
Timber Ridge	238	Groundwater

TABLE 2.9.1
PUBLIC WATER SUPPLY SYSTEMS IN LINN AND BENTON COUNTIES (CONTINUED)

Public Community Water System	Approximate Population Served	Primary Source Type
Urbana Water Supply	1,019	Groundwater
Van Horne Water Works	716	Purchased groundwater under the influence of surface water
Vinton Municipal Water Department	5,102	Groundwater

Source: EPA 2007a, 2007b

TABLE 2.9-2
PUBLIC WATER SUPPLY SYSTEMS IN LINN AND BENTON COUNTIES SERVING POPULATION OF MORE THAN 1,000

Public Community Water System	Total Design Capacity (GPD)	Average Daily Production (GPD)
Linn County		
ARC Marion Village	NA	71,000
Cedar Rapids Water Department	45,000,000	39,400,000
Center Point Water Supply	312,000	162,000
Central City	NA	155,846
Ely Water Supply	288,000	92,560
Fairfax Water Supply	144,000	119,000
Hiawatha Water Department	155,000	785,000
Lisbon Water Supply	250,000	136,000
Marion Municipal Water Department	6,500,000	2,579,000
Mount Vernon Water Supply	900,000	412,000
Springville Water Supply	288,000	124,000
Benton County		
Atkins Municipal Water Works	88,000	81,300
Belle Plaine Water Department	720,000	295,000
Poweshiek Water Association	NA	252,200
Urbana Water Supply	288,000	118,142
Vinton Municipal Water Department	1,225,000	507,750

GPD = gallons per day
Source: Lynam 2007.

2.10 METEOROLOGY AND AIR QUALITY

DAEC is located in Linn County, Iowa. Iowa has a continental climate typical of the Great Plains with cold, dry winters and hot humid summers. Iowa's interior continental location within the middle latitudes strongly influences the state's seasonal variations. During the six warmer months of the year, the prevailing moist, southerly flow from the Gulf of Mexico produces a summer rainfall maximum. The prevailing northwesterly flow of dry Canadian air in the winter causes a cold and relatively dry season. Iowa weather is also influenced by air masses from the Pacific Ocean, which produce comparatively mild and dry weather. Hot, dry winds from the desert southwest occasionally produce unusually high temperatures that desiccate crops. Thunderstorms, which are generally restricted to the spring and summer months, are accompanied by high winds and heavy rains, with occasional hail storms and tornados. Tornado frequency is highest in May and June. (NCDC 2006)

The region surrounding DAEC experiences weather patterns similar to the rest of the state, and the climate can be described as sub-humid and continental (DAEC 2005a). Winter temperatures average 22.5°F with summer temperatures averaging 72.1°F (NCDC 2002). Average annual precipitation 33.27 inches, of which 70 percent falls during the months of April through September. The average seasonal snowfall is approximately 31 inches (DAEC 2005a).

Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS), which specify maximum concentrations for carbon monoxide (CO), particulate matter with aerodynamic diameters of 10 microns or less (PM_{10}), particulate matter with aerodynamic diameters of 2.5 microns or less ($PM_{2.5}$), ozone, sulfur dioxide (SO_2), lead, and nitrogen dioxide (NO_2). Areas of the United States having air quality as good as or better than the NAAQS are designated by EPA as attainment areas. Areas having air quality that is worse than the NAAQS are designated by EPA as non-attainment areas. Those areas that were previously designated non-attainment and subsequently re-designated to attainment due to meeting the NAAQS are maintenance areas. States with maintenance areas are required to develop an air quality maintenance plan as an element of the State Implementation Plan.

Linn County, Iowa is part of the Northeast Iowa Intrastate Air Quality Control Region (AQCR) (40 CFR 81.256). The Northeast Iowa AQCR is in attainment for all air quality standards as are all counties in the state of Iowa (40 CFR 81.316). The nearest non-attainment area is the Metropolitan Chicago (Illinois-Indiana) Interstate AQCR, approximately 160 miles east of DAEC, which is designated as a non-attainment area under the $PM_{2.5}$ and 8-hour ozone NAAQS (40 CFR 81.314).

In October 2006, the EPA issued a final rule that revised the 24-hour $PM_{2.5}$ standard and revoked the annual PM_{10} standard (EPA 2006). Non-attainment designations for PM_{10} are not affected by the new rule, but additional non-attainment areas could be designated under the new $PM_{2.5}$ standard (EPA 2007c).

On March 12, 2008, the EPA issued a final rule that strengthens the 8-hour ozone standard (EPA 2008). Additional non-attainment areas could be designated under the new ozone standard.

The Clean Air Act, as amended, established 156 Mandatory Class I Federal Areas where visibility is an important issue. There are currently no Class I areas located within the state of Iowa or within 100 miles of DAEC. The closest Class I areas to DAEC are the Boundary Waters National Wilderness Area and Voyageurs National Park in Minnesota, Badlands National Wilderness Area in North Dakota, and Hercules-Glades and Mingo National Wilderness Areas in Missouri (40 CFR 81, Subpart D), all of which are in excess of 300 miles from DAEC

On July 11, 2008, the U.S. Court of Appeals for the D.C. Circuit vacated the entire Clean Air Interstate Rule (CAIR). As of this writing, the impact of this decision is unknown..

2.11 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Area History in Brief

The Paleo-Indian period dates from approximately 9500 to 7500 B.C. Paleo-Indians in Iowa encountered different environments than those of the recent past; the climate was cooler and wetter than present day. The landscape was covered by boreal and conifer hardwood forest, changing through time to elm- and oak-dominated woodlands throughout most of the state; prairie landscapes were limited.

The Early and Middle Archaic periods date from approximately 7500 to 2500 B.C. This period of history has been identified as a transitional time between cultures relying on hunting as the primary means of subsistence and cultures that were more adept at foraging for subsistence. The landscape changed to deciduous woodlands mixed with prairies. Large game hunting was supplemented by smaller game and the increased use of plant foods. Arid conditions became more prevalent during the Middle Archaic period and populations trended to establish semi-permanent and seasonal camps in the river valley areas. By the Late Archaic period, 2500 to 500 B.C., population density in Iowa had increased substantially, more sedentary populations were established, and both positive and negative interaction between cultures became more commonplace.

The Woodland settlements date from approximately 100 B.C to 1000 A.D. This era was characterized by continuous improvements in technology and more production efficiency. Hunter-gatherer adaptations were refined to include a greater reliance on aquatic species and dependence on cultivated plants. The production of ceramics and artwork increased. Weapon and tool making skills improved. Mound construction was generally simple during the Middle Woodland period but evolved into more complex groups of linear, effigy, and conical mounds for ritual and other purposes reflected in the Late Woodland period. The evolution of these, more complex, mound structures in northeast Iowa formed a distinctive element of seasonal settlement patterns of the Effigy Mound Culture, exploiting the vast array of seasonally available resources in the Mississippi valley regions.

The Plains Village pattern appeared in the Late Prehistoric times, 1000 to 1650 A.D., marking the beginning of a distinctive adaptation to tall grass prairies and short grass plains. This era was representative of many well-known cultures and historical tribes such as the Great Oasis, Mill Creek, and Central Plains tribes, common in the present-day midwestern area of the United States. The Oneota culture dominated much of eastern Iowa during the Late Prehistoric period. Distinct Oneota villages occupied widely separated regions of Iowa, however, there was probably a great deal of interaction and socio-political cooperation among them. Oneota complexes are ancestral to several midwestern tribes such as the Iowa, Oto, Missouri, and Winnebago.

After 1650 A.D., European influence drastically changed the structure of relationships among Indian groups. Tribal populations declined and European dispossession of traditional territories became common. Most of Iowa’s cities and towns were established by the mid-1800s. Agricultural homesteads were widespread and industries such as lead and coal mining flourished across the state. (Schermer et al.1995)

The Amana colonies arrived in Iowa near the mid-1800s, originating from German-speaking European settlers belonging to the church known as the Community of True Inspiration. The religious group was a breakaway from the Lutheran Church consisting of parishioners who desired to focus more on the spiritual needs of the congregation rather than on intellectual debate and formalized worship ceremonies. The Amana colonies flourished under an established communal system comprised self-sustaining village complexes. In 1932, members of the community created a business enterprise to operate for profit (Amana Society, Inc.), providing a separation between the traditional church and the economic functions of the community. Today, the Amana culture remains a stable and profitable community based on successful years in the fields of industry, textiles, and farming. The Amana Church continues to be a vital part of the community and the historic Amana Villages remain an important aspect of historical preservation efforts of local communities in Iowa (NPS 2007a).

Pre-Operation and Operational Historic/Archaeological Analysis

The Final Environmental Statement for the Duane Arnold Energy Center stated that no historic sites for Linn or Benton Counties were listed on the National Register of Historic Places. At that time, the State of Iowa was in the preliminary stages of developing listings of historic sites for the state but no specific details were yet available. It was noted that some historic sites would probably be designated in Cedar Rapids, but they would not be adversely affected by the DAEC. In addition, the Cedar River Valley was known to be rich in archaeological history, but inspections by the State Archaeologist revealed no archaeological or historic sites of significance in the area of the plant site. Correspondence with the Federal Advisory Council on Historic Preservation, United States Department of the Interior, and the State Historical Society of Iowa concluded that construction and operation of the DAEC would not affect historic or archaeological resources (AEC 1973).

Three studies have been performed on DAEC property in the last six years to determine impacts to known archaeological sites or the presence of new archaeological sites. In 2001, the University of Iowa conducted a Phase I Intensive Survey in preparation for construction of the Independent Spent Fuel Storage Facility on 8.5 acres of land north of the plant (UI 2001). In 2005, Phase I studies were performed for a seven-acre parcel of land west of the plant for the construction of a communications tower (Higginbottom 2005). In 2006, Phase I studies were performed along 1,350 feet (1.9 acres) of the Cedar River adjacent to the plant for a river bank stabilization project (SHPO 2006). In all three cases, there were no impacts to known archaeological sites, nor were there any new archaeological sites discovered. The State Historical Society of Iowa concurred with each determination made of “no historic properties affected" (UI 2001; Higginbottom 2005; SHPO 2006).

Current Historic/Archaeological Analysis

DAEC's excavation and trenching procedure (DAEC 2008) describes the environmental review of land-disturbing activities and accidental discovery of Archaeological, Cultural, and Historic Resources (AC&H Resources). Environmental reviews are performed by the DAEC Environmental Coordinator (EC) who serves as the knowledgeable contact for AC&H Resources. The EC coordinates communication between the plant owner representative, qualified archaeological contractors, and the State Historic Preservation Officer/State Archaeologists. The EC is also responsible for making recommendations for completing a proposed project (DAEC 2008).

As of 2007, 10 properties in Benton County and 75 properties in Linn County have been listed in the National Register of Historic Places. Of these 85 properties, 3 fall within a 6-mile radius of DAEC: Shellsburg Bridge, Chain Lakes Bridge, and Taylor-Van Note (NPS 2007b and 2007c).

The only federally-recognized tribe in Iowa is the Sac & Fox Tribe of the Mississippi in Iowa (NCSL 2007). The tribe is located in Tama County on 4,300 acres in south central Iowa known as the Meskwaki Indian Settlement. The Settlement is located 130 miles from the Mississippi River (Iowa's eastern border) and the Iowa River runs through the southeast portion of their land. All lands are commonly owned with no individual allotments (EDA 2007). The population of the Iowa tribe in 2000 was 761 (USCB 2000c). The Settlement is governed by a seven-member tribal council. The tribe's primary revenue source is gaming (bingo and casino); the tribe also leases 520 acres of farmland to farmers who raise corn and soybeans (EDA 2007).

As stated in Section 2.1, Wickiup Hill is a 563-acre natural area located east of DAEC and the Cedar River which includes the 240-acre Wickiup Hill Outdoor Learning Area and 10,000 square-feet Learning Center. This learning center offers Native American and archaeological exhibits featuring replicas of prehistoric and historic artifacts excavated at Wickiup Hill. The learning center also offers an Archaeological Day Camp where students work with an archaeologist on the property (LCCD 2007b). The site is prehistoric, believed to be from the Woodland period. The site is utilized by numerous professional and amateur archeological associations, with particular interest in the artifacts of former Indian villages and the Indian Burial Mound structures (INHF 2004). One of the DAEC Transmission Lines (Hiawatha 161 kV Line), crosses the Wickiup Hill property just north of the Indian Burial Mound areas (AEC 1973 and WHT 2006). No archeological sites have been documented in this right-of-way.

2.12 KNOWN OR REASONABLY FORESEEABLE PROJECTS IN THE DAEC VICINITY

DAEC is located in Linn County approximately 2.5 miles north-northeast of the Town of Palo, Iowa and approximately 3 miles east of Benton County, Iowa. Cedar Rapids is located approximately 5.7 miles southeast of DAEC.

Industries in the DAEC Vicinity

Linn County is Iowa's largest manufacturing center (Linn County 2007). In March 2007, the "Envirofacts Warehouse" online database provided by the EPA listed a total of 790 EPA-regulated facilities in Linn County, concentrated in Cedar Rapids. The list included 445 industries that produce and release air pollutants; 57 facilities that reported toxic releases; 447 facilities that reported hazardous waste activities; and 57 facilities that are permitted to discharge to waters of the United States. There are 10 Superfund sites in Linn County: the 1st Avenue SE site, Brandy Wine Mercury, Cedar Rapids National Guard Target Range, Cedar Rapids Manufactured Gas Plant (former), Cedar Rapids Sewage Treatment Plant, Cedar Rapids Sludge Incinerator, Coggon Creamery, Electro Coatings of Iowa Inc., Ralston Site, and US Nameplate Company (EPA 2007d).

A March 2007 search of the Envirofacts Warehouse for Benton County, Iowa determined that 31 industries produced and released air pollutants; 3 facilities reported toxic releases; 54 facilities reported hazardous waste activities; and 26 facilities were permitted to discharge to waters of the United States. There is one Superfund site in Benton County, the Belle Plaine Coal Gasification site. (EPA 2007e)

Within six miles of DAEC (Figure 2.1-2), there are no manufacturing industries. The six-mile vicinity has numerous service industry businesses such as hair salons and banks. There is also a large dairy product distribution center, horticulture nursery, and a strawberry farm. There are no known planned industries.

Federal Facilities in the Vicinity of DAEC

There are no known federal facilities within fifty miles of DAEC.

Energy Facilities in the Vicinity of DAEC

There are no other energy facilities within the six-mile vicinity of DAEC. Within 50 miles of DAEC there are six fossil-fuel fired generating facilities. Three are located in Cedar Rapids: the 6th Street Generating Station, the Prairie Creek Generating Station and the Archer Daniels Midland Cedar Rapids Plant. The other three fossil-fuel fired generating facilities are located in Black Hawk County: the Streeter Station, the Electrifarm Generating Station, and the Cedar Falls Gas Turbine Station (Walter 1988, IDNR 2005). In addition, Elk Run Energy Associates, LLC has proposed a new 750-megawatt coal-fired electric generating plant east of Waterloo in Black Hawk County (IUB 2007).

Iowa is the nation's leading producer of ethanol (EIA 2007a). Four ethanol production plants in Cedar Rapids, Blairstown, Fairbank, and Hopkinton are located within 50 miles of DAEC. Five other ethanol production plants in the planning or construction phase are also located within 50 miles of DAEC. Penford Corporation and Archer Daniels Midland plan to construct plants in Cedar Rapids; US Bio Energy/Big River Resources, LLC plans to construct a plant in Grinnell; Xethanol Biofuels, LLC plans to construct a plant in Blairstown; and Tama Ethanol, LLC plans to construct a plant in Tama (Iowa Corn 2007; ACE 2008).

Independent Spent Fuel Storage Installation at DAEC

DAEC has dry cask storage modules for radioactive, spent nuclear fuel located at the plant. The storage modules are operated in accordance with 10 CFR 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactors."

3.0 PROPOSED ACTION

NRC

"…The report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)

FPL Energy Duane Arnold, LLC (FPL-DA) proposes that the U.S. Nuclear Regulatory Commission (NRC) renew the operating licenses for Duane Arnold Energy Center (DAEC) for an additional 20 years. Renewal would give FPL-DA and the State of Iowa the option of relying on DAEC to meet future electricity needs. Section 3.1 discusses the plant in general. Sections 3.2 through 3.4 address potential changes that could occur as a result of license renewal.

3.1 GENERAL PLANT INFORMATION

General information about DAEC is available in several documents. In 1973, the U.S. Atomic Energy Commission (predecessor to the Nuclear Regulatory Commission) published the Final Environmental Statement Related to the Operation of Duane Arnold Energy Center (AEC 1973). The Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996e) describes DAEC features and, in accordance with NRC requirements, FPL-DA maintains the Final Safety Analysis Report for DAEC (DAEC 2005a). FPL-DA has referred to each of these documents while preparing this environmental report for license renewal.

3.1.1 REACTOR AND CONTAINMENT SYSTEMS

DAEC is a single unit plant with a boiling water reactor (BWR). The nuclear steam supply system (NSSS) and the turbine-generator were supplied by General Electric. The balance of plant was designed and constructed by Bechtel Power Corporation as architect-engineer and construction contractor. The plant achieved initial criticality on March 23, 1974, and began commercial operation on February 1, 1975. (DAEC 2005a)

The unit was originally designed, analyzed, and licensed for a rated core power of 1,658 megawatts-thermal (MWt), but the plant Technical Specifications restricted operations to a rated power of 1,593 MWt. Technical Specifications were amended in 1985 (License Amendment 115) and rated power (100 percent) became 1,658 MWt and the net electric output became 541 megawatts-electrical (MWe). In 2001, the rated power level was increased again to 1,912 MWt by the Extended Power Uprate (EPU) Project (License Amendment 243) (DAEC 2005a). Since 2001, the generating capacity has been incrementally increased to its present value of about 610 MWe (FPL 2007b).

The nuclear steam supply system at DAEC is typical of General Electric BWRs. The reactor core produces heat that boils water. This creates steam which, after drying, is routed to the turbines. The steam yields its energy to the turbines, which are connected to the electrical generator. DAEC uses a BWR/4 reactor design and a Mark I primary containment design (NRC 2007a).

The DAEC reactor is on a 24-month refueling cycle (NRC 2001). The reactor fuel is uranium dioxide pellets sealed in Zircalloy-2 tubes. The number of fuel assemblies in the complete core is 368 (DAEC 2005a). The batch average burnup of the fuel assemblies is between 33,000 and 60,000 megawatt-days per metric ton uranium (MWd/MtU) due to the fuel consumption increase from the 2001 extended power uprate. To support the extended burnup, the U-235 enrichment level was increased to greater than 4 weight percent but less than 5 weight percent (NRC 2001).

The primary containment for each 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. The containment systems and their engineered safeguards are designed to ensure that offsite doses resulting from postulated accidents are well below the guidelines in 10 CFR 100.

3.1.2 COOLING AND AUXILIARY WATER SYSTEMS

At DAEC, the Circulating Water and the Service Water Systems draw from the Cedar River. The cooling tower blowdown is discharged to the same river, downstream of the intake (DAEC 2005a). Groundwater is withdrawn from four wells for domestic use and for other industrial purposes including the makeup water treatment system and the plant ventilation cooling water (DAEC 2005a). The following subsections describe water systems at DAEC.

3.1.2.1 Surface Water

DAEC 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 (DAEC 2005a). 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. The intake structure for the River Water Supply System is also the intake for the residual heat removal service water (RHRSW) and emergency service water (ESW).

The intake structure is located on the west bank of the Cedar River (Figure 2.1-3). This location was selected because the largest river flows occur near the west bank and lateral movement of the sediment is toward the east bank due to the secondary currents created by a bend upstream (DAEC 2005a). In order to maintain these conditions during very low flow, an overflow barrier across the river was constructed in accordance with Seismic Category I criteria to intercept the streambed flow and divert it to the intake structure. This makes the entire flow of the river available (DAEC 2005a).

The intake structure is constructed of reinforced concrete. The underground portions of the structure serve as channels for incoming water and the upper portions enclose the motors and controls (DAEC 2005a, page 1.2-6). River water enters the parallel pump pits of the Intake Structure by passing through trash bars, a sand control gate, and a traveling screen, located on both intake sides (DAEC 2006b, page 6).

Cedar River water diverted into the Intake Structure passes through bar racks to two parallel intake channels within the intake structure. A trash rake is located on the outdoor deck of the intake structure to remove debris accumulated on the bar racks. (DAEC 2005a)

An electrically-operated gate is provided at the mouth of each intake channel to control the amount of sand traveling into the pump pits. These gates may also be raised or lowered by a hoist to maintain acceptable water differential. A manually-operated gate is provided between the two pump pits so that either of the two traveling screens may serve either or both pump pits. A 24-inch line is provided to deliver warming water from either cooling tower blowdown or RHR Service Water or Emergency Service Water system output to flood the bar screens for de-icing in the winter months. (DAEC 2005a)

At the inlet end of each channel, the water passes through traveling screens into a separate pump wet pit. Each traveling screen is operated individually under automatic control, but with manual override to permit continuous operation. Wash water is supplied by a screen wash pump to release impinged aquatic organisms and debris from the screens. Traveling screen operation will cease upon failure of its screen wash supply. (DAEC 2005a)

Each of the two pump wet pits contain two vertical turbine pumps rated at 6,000 gallons per minute (gpm) each. The two paired pumps of each pit discharge into an 18-inch pipe and then into a common 24-inch pipeline for each subsystem which, in turn, discharges into the stilling basin in the pump house. The stilling basin is configured to underflow to the RHRSW/ESW wet pits and overflow to the circulating water pit. The circulating water pit provides a source of water for the Circulating Water System, the General Service Water System, and the Fire Water System (DAEC 2006b).

Water is withdrawn from the cooling tower basins, circulated through the main condensers, and returned to the cooling towers at the rate of 310,000 gpm (155,000 gpm per tower) (DAEC 2006c). Each of the two cross-flow forced draft Cooling Towers is 60 feet tall with a base measuring 16,000 square feet (IELP 1971, DAEC 2006c). The maximum river water supply requirements are 8,100 gpm for evaporative dissipation, including drift, and 3,100 gpm for blowdown (at 3.5 cycles of concentration) for a total withdrawal of 11,200 gpm (DAEC 2005a).

The Iowa Department of Natural Resources (IDNR) has established a protected flow of 500 cubic feet per second (cfs) (269 million gallons per day) in the Cedar River as monitored at the official gage at Cedar Rapids. As a consequence, when the river flow is below 500 cfs an amount of water equal to the consumptive use of river water is discharged from the Pleasant Creek Recreational Reservoir to allow continued withdrawal by DAEC (IDNR 2004a). This 410-acre reservoir was 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 regional recreation opportunities (IDNR 2007a). IDNR permits consumptive use of 16,000 acre-feet per year at a maximum rate of 15,000 gpm. Consumptive use of surface water, as well as water withdrawal, is monitored and data is provided to IDNR annually (IDNR 2004a).

Finally, approved water treatment chemicals (e.g., sodium hypochlorite and sodium bromide, non-oxidizing biocides, scale inhibitors, etc.) are injected into the Circulating Water and Service Water Systems to minimize fouling in the pipes and condensers in accordance with the National Pollutant Discharge Elimination System (NPDES) permit (DAEC 2005a IDNR 2004c).

3.1.2.2 Groundwater Resources

The DAEC Well Water System consists of four independent groundwater wells. The wells are physically separated from one another by at least 720 feet to equalize drawdown and are at least 1,100 feet from the plant. (DAEC 2006a). The wells are sealed to prevent collection from shallow water sources (DAEC 2005a). All four wells tap deep Devonian/Silurian formations (DAEC 2005a). Groundwater from the plant flows away from the wells toward the river (DAEC 2005a).

Well B (1P-58B) is approximately 1,500 feet southwest of the reactor building. Well A (1P-58A) is approximately 2,000 feet north of Well B. Well C (1P-58C) is approximately 720 feet south of Well B and Well D (1P-58D) is approximately 1,500 feet northeast of the reactor building (DAEC 2005a) (See Figure 2.1-3). Wells B and D are protected from the weather by their own buildings and space heaters. The pumps for wells A and C are submersible and are installed at least 250 feet deep in their wells with well houses protecting above-ground equipment from the weather (DAEC 2006a).

The four wells are connected to a 10-inch common header that provides the site with water for use as: potable and sanitary water, plant ventilation cooling water, circulating water pump seals, and circulating water and service water for chemical treatment systems. When general service water is not available, the Well Water System provides for an alternate source of water for emergency reactor injection, the Fire Protection System, and cooling to the Reactor Building Closed Cooling Water (RBCCW) heat exchangers (DAEC 2006a, DAEC 2006d). System needs are met by using well B or well D or wells A and C together. (DAEC 2006a).

At DAEC, groundwater is lost by being: 1) discharged to the Cedar River through the station's Sewage Treatment Plant, 2) discharged to the river from the Cooling Tower basins via the blowdown line, 3) reused in the Circulating Water System back to the station for cooling, 4) evaporated through plant vents (demineralized water), or 5) evaporated to the atmosphere through the Cooling Towers. Consumptive use of groundwater, as well as water withdrawal, is permitted by the IDNR and monitoring data is provided to them annually (IDNR 2002).

3.1.3 WASTEWATER TREATMENT

Liquid effluents (including de-chlorinated cooling tower blowdown) are discharged to the Cedar River via an open canal (approximately 1,700 feet long) and a discharge structure located immediately downstream of the intake (Figure 2.1-3) (AEC 1973). The discharge structure consists of an 18-inch diameter pipe with a reducer at the outfall which results in a 15-inch discharge stream. The opening of the discharge pipe is oriented so that the discharge occurs at the bottom of the river (on the western shore) in the downstream direction but pointing upward to the surface at an angle of 20º to the horizontal. The discharge structure also includes a discharge weir above the level of the discharge pipe. When flow in the discharge canal goes above 4,000 gpm, such as during heavy rains, the flow goes over the weir and discharges into an open canal and then into the river (AEC 1973).

The Sewage Treatment Facility (STF) was put into operation in 1988 with a design capacity of 54,000 gallons per day (based on a 30-day average). Domestic wastewater from the energy, badging, and training centers is directed by gravity to a pumping station located west of the STF. The wastewater is then pumped to the STF, where it passes through the comminutor (grinder) before entering one of two sequencing batch aerobic digesters for processing. Sludge is transferred to the aerobic digestion tank for stabilization and the wastewater is then disinfected by chlorination for discharge (DAEC 1988). Because water makes up the majority of the sewage processed by the STF, approximately 9,500 gallons per day (gpd) of water are discharged from the system, roughly approximating the sewage flow into the facility (DAEC 2005b). Effluent from the STF is discharged to the Cedar River within limits prescribed in the site NPDES permit. Discharge is via an open ditch to an outfall located approximately one-half mile upstream from the river intake and discharge structures (AEC 1973).

3.1.4 RADIOACTIVE WASTE SYSTEM

The radioactive waste systems are designed to collect, process, and dispose of potentially radioactive wastes produced during the operation of the plant. These wastes are grouped as liquid, gaseous, or solid.

3.1.4.1 Liquid Waste System

The liquid radioactive waste system is divided into several subsystems so that the liquid wastes from various sources can be kept segregated and processed separately. Cross-connections between the subsystems provide additional flexibility for the processing of the wastes by alternative methods. The 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 Ultra Violet Ozone (UV03) Treatment System. Radioactive liquids are recycled within the plant to the extent practicable. Since 1985, the DAEC has not discharged liquid radioactive waste.

Expected annual liquid volume total for floor drain, detergent, and chemical wastes is 2,873,000 gallons. (DAEC 2005a)

3.1.4.2 Gaseous Waste System

The gaseous wastes are processed through a recombiner-charcoal delay system, monitored, and released to the atmosphere via the offgas stack. Solid wastes are packaged in suitable containers for offsite shipment and burial. The gaseous effluents from the treatment systems are continuously monitored and the discharges are terminated if the effluents exceed pre-set radioactivity levels. (DAEC 2005a)

3.1.4.3 Solid Waste System

The solid radioactive waste system processes wet and dry solid wastes. The wet solid wastes are the spent demineralizer resins and filter sludges that are byproducts of plant water treatment processes. The dry solid wastes consist of other miscellaneous radioactive or contaminated solid wastes. Miscellaneous solid wastes result from operation and maintenance. Air filters, contaminated clothing, and used reactor equipment are typical of these wastes. The estimated annual maximum weight and volume of solid waste processed in the radioactive waste system are 63,000 pounds and 2,200 cubic feet. (DAEC 2005a)

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. Material that can be compressed is compacted into either 55-gallon drums by a hydraulic press or metal containers by a box trash compactor, both of which are located in the Low Level Radwaste Processing and Storage Facility. Because of high activation and contamination levels, used reactor components are stored in the spent-fuel pool to allow for radioactive decay before removal to in-plant, onsite, or offsite storage and final offsite disposal. Otherwise, the wastes are stored onsite only until quantities large enough for economical shipment are accumulated.

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 former is dispositioned by the processor while the radioactive component is sent for offsite burial (DAEC 2005a)

Radioactive wastes are shipped to offsite facilities for treatment and/or disposal. 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 requirements by truck and by rail. The numbers of shipments from 2002 through 2006 are presented in Table 3.1-1.

3.1.4.4 Non-Radioactive Solid Waste System

DAEC generates nonradioactive solid waste such as office trash, break room waste, and packaging waste as well as industrial solid waste such as uncontaminated used equipment and maintenance waste. DAEC also collects certain materials for recycling such as batteries, oil, and cardboard. These waste streams are collected and shipped offsite for recycling or disposal in local landfills.

DAEC is a small quantity generator of non-acute hazardous waste with an EPA issued generator ID number. These wastes are collected and stored in the Facilities Storage Area for no more than 180 days. The waste is sent to a licensed processor for final disposition.

3.1.5 TRANSMISSION FACILITIES

As described in the Final Environmental Statement (FES), 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). Since the FES was written, one additional 161 kV line connecting DAEC to the Sixth Street Generating Station substation was built in 1978. These lines not only disperse power from the site, but also meet the load demand of the growing grid system of the surrounding region in all directions. Figure 3.1-1 is a map of the transmission system and is described below.

- Hills 345 kV Line – single circuit line which runs westward from DAEC in a 665-foot 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 where it turns south to the Hills substation feed, an existing 345 kV line (described below) which runs in the north-south direction approximately 3.5 miles west of the site.
- Hazelton 345 kV Line – single circuit line which runs westward from DAEC in a 665-foot 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 345 kV line (described below) which runs north-south direction approximately 3.5 miles west of the site.
- Washburn 161 kV Line – single circuit line which shares the westward 500–665 foot corridor with the Hills and Hazelton lines and continues west 16 miles to the Garrison substation, then an additional 30 miles north to the Washburn substation.

- Bertram 161 kV Line – single circuit line which shares the westward 665-foot corridor with the Hills-Hazelton lines for 0.34 miles then continues southeast in a 100-foot corridor to Bertram substation with a total distance of 28 miles.
- Hiawatha 161 kV Line – 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 – 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 (DAEC 1978).

The Hazelton and Hills lines were tied into an existing line that pre-dates construction of DAEC. The pre-existing line, which crosses one arm of the Pleasant Creek Reservoir to the northwest of the site, was built in 1966 as part of the Twin Cities-Iowa-St. Louis 345 Interconnection Transmission System. This 345 kV line was physically divided into two separate lines when the ties were made. The portion of the line that runs north from the DAEC tie point to the Hazelton substation became known as the Hazelton line. The portion of the line that runs south from the DAEC tie point to the Hills substation became known as the Hills line. The Twin Cities-Iowa-St. Louis line was a pre-existing line and is not within the scope of interest of this Environmental Report because it was not constructed for the specific purpose of connecting DAEC to the transmission system (AEC 1973).

The DAEC 345–161 kV substation is located approximately one-quarter mile west of the plant. The main transformer has a rating of 600,000 kilovolt-amps, is located on the east side of the turbine building and is approximately 550 feet away from the nearest cooling tower (IELP 1971). Other than the site substation, the Hiawatha substation was the only one constructed for the operation of DAEC. All other substations were already in service (AEC 1973).

As stated in Chapter 1, the transmission assets connecting DAEC to the grid are owned by ITC Midwest LLC (ITC). The transmission assets include 101 miles of corridor that occupy approximately 1,370 acres for the specific purpose of connecting DAEC to the transmission system (AEC 1973). Of the 1,370 acres, approximately 460 were existing rights-of-way (AEC 1973, DAEC 1978). Of the 101 miles, 32 miles are along railroads, 2 miles are along secondary public roads, and 67 miles are over private property. The corridors pass through land that is primarily agricultural or forest land (AEC 1973, DAEC 1978).

All DAEC transmission lines were designed and constructed in accordance with industry standards that were current when the lines were built. Ongoing surveillance and maintenance of DAEC-related transmission facilities by Alliant ensures continued conformance to design standards. These maintenance practices are described in Sections 4.13. Section 4.13 also examines the conformance of the lines with the National Electrical Safety Code requirements on line clearance to limit shock from induced currents.

These transmission lines, which are integral to the larger transmission system, are expected to be maintained indefinitely. Except for the short ties, these transmission lines will remain a permanent part of the midwest transmission system even after DAEC is decommissioned.

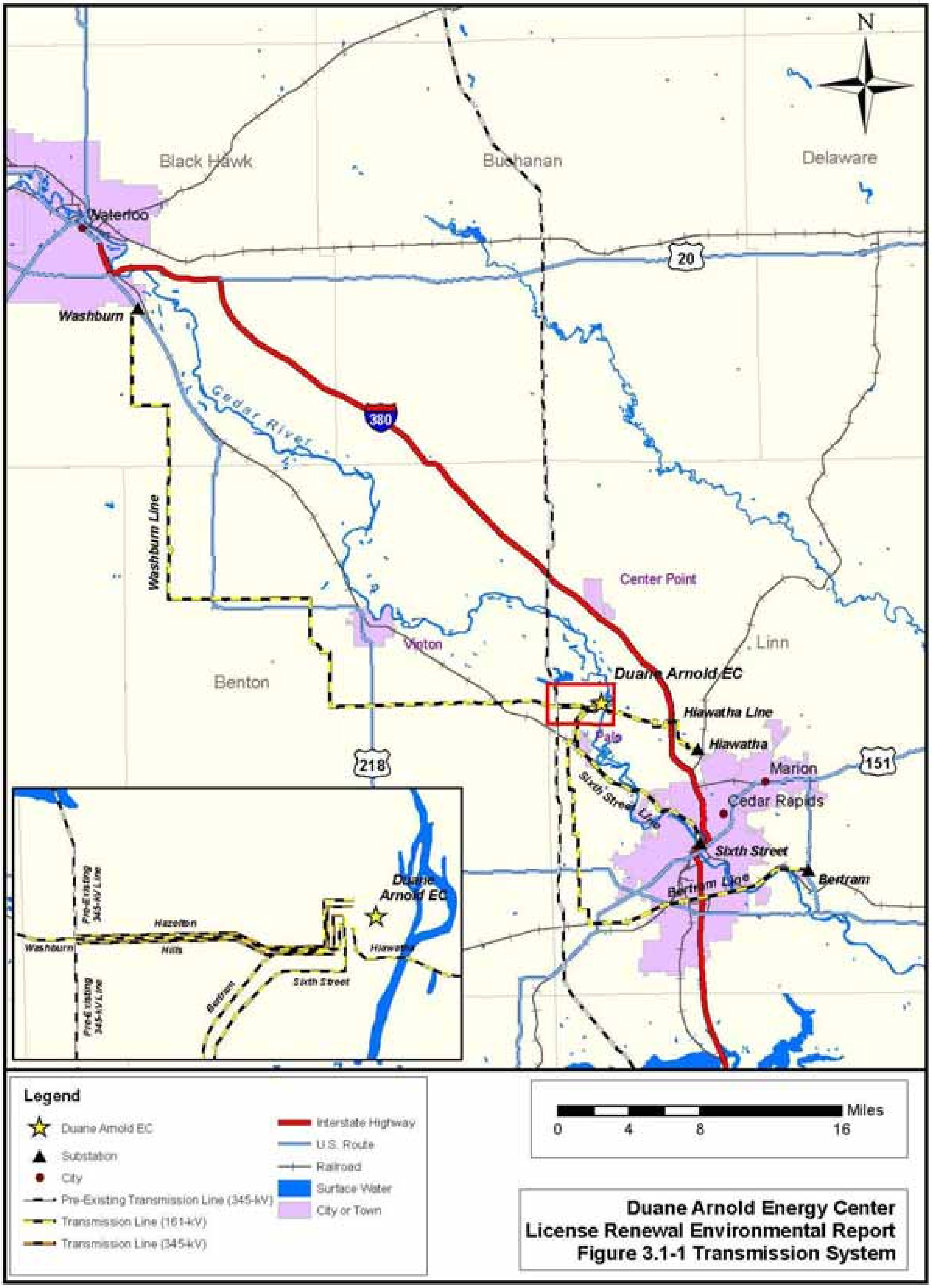
Switchyard and Transmission Lines

TABLE 3.1-1
DUANE ARNOLD ENERGY CENTER NUMBER OF RADIOACTIVE MATERIAL SHIPMENTS

2002	2003	2004	2005	2006
5	11	11	14	7

DAEC 2002, DAEC 2003, DAEC 2004b, DAEC 2005c, and DAEC 2006e

FIGURE 3.1-1 TRANSMISSION SYSTEM



3.2 REFURBISHMENT ACTIVITIES

NRC

> **"… The report must contain a description of … the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)**
>
> **"… The incremental aging management activities carried out to allow operation of a nuclear power plant beyond the original 40 year license term will be from one of two broad categories: ... and (2) major refurbishment or replacement actions, which usually occur fairly infrequently and possibly only once in the life of the plant for any given item…." NRC 1996e**

FPL-DA has addressed refurbishment activities in this environmental report in accordance with NRC regulations and complementary information in the NRC GEIS for license renewal (NRC 1996e). NRC requirements for the renewal of operating licenses for nuclear power plants include the preparation of an integrated plant assessment (IPA) (10 CFR 54.21). The IPA must identify and list systems, structures, and components subject to an aging management review. Items that are subject to aging and might require refurbishment include, for example, 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.

In turn, NRC regulations for implementing the National Environmental Policy Act require environmental reports to describe in detail and assess the environmental impacts of refurbishment activities such as planned modifications to systems, structures, and components or plant effluents [10 CFR 51.53(c)(2)]. 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.

The GEIS (NRC 1996e) provides helpful information on the scope and preparation of refurbishment activities to be evaluated in this environmental report. It describes major refurbishment activities that utilities might perform for license renewal that would necessitate changing administrative control procedures and modifying the facility. The GEIS analysis assumes that an applicant would begin any major refurbishment work shortly after NRC grants a renewed license and would complete the activities during five outages, including one major outage at the end of the 40th year of operation. The GEIS refers to this as the refurbishment period.

GEIS Table B.2 lists license renewal refurbishment activities that NRC anticipated generation companies might undertake. In identifying these activities, the GEIS intended to encompass actions that typically take place only once, if at all, in the life of a nuclear plant. The GEIS analysis assumed that a generation company would undertake these activities solely for the purpose of extending plant operations beyond 40 years, and would undertake them during the refurbishment period. The GEIS indicates that many plants will have undertaken various refurbishment activities to support the current license period, but that some plants might undertake such tasks only to support extended plant operations.

The DAEC IPA that FPL-DA conducted under 10 CFR 54 has not identified 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 has included the IPA as part of its License Renewal application.

3.3 PROGRAMS AND ACTIVITIES FOR MANAGING THE EFFECTS OF AGING

NRC

> **"…The report must contain a description of … the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)**
>
> **"…The incremental aging management activities carried out to allow operation of a nuclear power plant beyond the original 40 year license term will be from one of two broad categories: (1) SMITTR actions, most of which are repeated at regular intervals …." NRC 1996e (SMITTR is defined in NRC 1996 as surveillance, monitoring, inspections, testing, trending, and recordkeeping.)**

The IPA required by 10 CFR 54.21 identifies the programs and inspections for managing aging effects at DAEC. These programs are described in the Duane Arnold Energy Center License Renewal Application, Appendix B, Aging Management Programs and Activities. Other than implementation of the programs and inspections identified in the IPA, there are no planned modifications of DAEC administrative control procedures associated with license renewal.

3.4 EMPLOYMENT

Current Workforce

FPL-DA employs a nuclear-related permanent workforce of approximately 669 employees; this is within the range of 600 to 800 personnel per reactor unit estimated in the GEIS (NRC 1996e). Table 3.4-1 provides permanent employee data for DAEC. Approximately 70.1 percent of the permanent DAEC employees live in Linn County and 13.6 percent live in Benton County. About 9.0 percent of the permanent workforce is distributed across 14 additional counties in Iowa with numbers ranging from 1 to 25 employees per county. The remaining 7.3 percent of the permanent workforce have permanent addresses distributed across 43 counties in 22 states.

The DAEC reactor is on a 24-month refueling cycle. During refueling outages, site employment increases above the permanent workforce by as many as 1,000 workers for temporary duty (25 to 30 days).

License Renewal Increment

Performing the license renewal activities would necessitate increasing the DAEC staff workload by some increment. The size of this increment would be a function of the schedule within which FPL-DA must accomplish the work and the amount of work involved. Having determined that it would not undertake refurbishment (Section 3.2), FPL-DA focused its analysis of license renewal employment increment on programs and activities for managing the effects of aging (Section 3.3).

The GEIS (NRC 1996e) assumes that NRC would renew a nuclear power plant license for a 20-year period. The GEIS further assumes that the utility would initiate surveillance, monitoring, inspection, testing, trending, and recordkeeping (SMITTR) activities at the time of issuance of the new license and would conduct license renewal SMITTR activities throughout the remaining life of the plant, sometimes during full-power operation, but mostly during normal refueling and the 5- and 10-year in-service refueling outages (NRC 1996e).

FPL-DA has determined that the GEIS scheduling assumptions provide a reasonable basis for estimating the incremental workload attributable to license renewal at DAEC. Many DAEC license renewal SMITTR activities would have to be performed during outages. Although some DAEC license renewal SMITTR activities would be one-time efforts, others would be recurring periodic activities that would continue for the life of the station.

The GEIS estimates that the most additional personnel needed to perform license renewal SMITTR activities would typically be 60 persons during the 3-month duration of a 10-year in-service refueling. Having established this upper value for what would be a single event in 20 years, the GEIS uses this number as the expected number of additional permanent workers needed per unit attributable to license renewal. GEIS

Section 4.7 uses this approach in order to "...provide a realistic upper bound to potential population-driven impacts…."

FPL-DA expects that existing fluctuations in worker population for routine activities, such as outages, will enable FPL-DA to perform the increased SMITTR workload without adding staff. Therefore, FPL-DA has no plans to add non-outage employees to support DAEC operations during the license renewal term. Nor does it have plans to increase the typical number of outage employees during the license renewal term.

TABLE 3.4-1
COUNTIES OF RESIDENCE FOR PERMANENT WORKFORCE

County	State	Number of Employees	Percentage of Workforce	County Population, 2000 [b]	Percentage of County Population
Linn	IA	469	70.10%	191,701	0.24%
Benton	IA	91	13.60%	25,308	0.36%
Johnson	IA	25	3.74%	111,006	0.02%
Buchanan	IA	7	1.05%	21,093	0.03%
Iowa	IA	5	0.75%	15,671	0.03%
Jones	IA	5	0.75%	20,221	0.02%
Cedar	IA	3	0.45%	18,187	0.02%
Scott	IA	3	0.45%	158,668	< 0.01%
Black Hawk	IA	2	0.30%	128,012	< 0.01%
Delaware	IA	2	0.30%	18,404	0.01%
Cerro Gordo	IA	1	0.15%	46,447	< 0.01%
Clayton	IA	1	0.15%	18,678	0.01%
Clinton	IA	1	0.15%	50,149	< 0.01%
Jasper	IA	1	0.15%	37,213	< 0.01%
Jefferson	IA	1	0.15%	16,181	0.01%
Mahaska	IA	1	0.15%	22,335	< 0.01%
Story	IA	1	0.15%	79,981	< 0.01%
Tama	IA	1	0.15%	18,103	0.01%
Out of State [a]	---	49	7.32%	---	---

a. Out of State employees are distributed across 43 counties in 22 states.
b. Source: USCB 2003b

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND MITIGATING ACTIONS

NRC

"The report must contain a consideration of alternatives for reducing impacts…for all Category 2 license renewal issues…." 10 CFR 51.53(c)(3)(iii)

"The environmental report shall include an analysis that considers…the environmental effects of the proposed action…and alternatives available for reducing or avoiding adverse environmental effects." 10 CFR 51.45(c) as adopted by 10 CFR 51.53(c)(2)

The environmental report shall discuss the "…impact of the proposed action on the environment. Impacts shall be discussed in proportion to their significance…." 10 CFR 51.45(b)(1) as adopted by 10 CFR 51.53(c)(2)

"The information submitted…should not be confined to information supporting the proposed action but should also include adverse information." 10 CFR 51.45(e) as adopted by 10 CFR 51.53(c)(2)

Chapter 4 presents an assessment of the environmental consequences associated with the renewal of the Duane Arnold Energy Center (DAEC) operating license. The U.S. Nuclear Regulatory Commission (NRC) has identified and analyzed 92 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated the issues as Category 1, Category 2, or NA (not applicable). NRC designated an issue as Category 1 if, based on the result of its analysis, the following criteria were met:

- the environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;
- a single significance level (i.e., small, moderate, or large) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent-fuel disposal); and
- 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.

If the NRC analysis concluded that one or more of the Category 1 criteria could not be met, NRC designated the issue as Category 2. NRC requires plant-specific analyses for Category 2 issues.

Finally, NRC designated two issues as NA, signifying that the categorization and impact definitions do not apply to these issues. One of these issues, environmental justice, is addressed in this document and treated as a Category 2 issue. In accordance with 10

CFR 51 the other issue, chronic effects from electromagnetic fields, is not addressed in this environmental report.

NRC rules do not require analyses of Category 1 issues that NRC resolved using generic findings (10 CFR 51) as described in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996e). An applicant may reference the generic findings of GEIS analyses for Category 1 issues. Appendix A of this report lists the 92 issues and identifies the environmental report section that addresses each issue.

CATEGORY 1 AND NA LICENSE RENEWAL ISSUES

NRC

> **"The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in Appendix B to subpart A of this part." 10 CFR 51.53(c)(3)(i)**
>
> **"…[A]bsent new and significant information, the analyses for certain impacts codified by this rulemaking need only be incorporated by reference in an applicant's environmental report for license renewal…." (NRC 1996a, pg. 28483)**

FPL Energy Duane Arnold, LLC (FPL-DA) has determined that 8 of the 69 Category 1 issues do not apply to DAEC because they are specific to design or operational features that are not found at the facility. Because FPL-DA is not planning any refurbishment activities, 7 additional Category 1 issues related to refurbishment do not apply. Appendix Table A-1 lists the 69 Category 1 issues, indicates whether or not each issue is applicable to DAEC, and if inapplicable, provides the FPL-DA basis for this determination. Appendix Table A-1 also includes references to supporting analyses in the GEIS where appropriate.

FPL-DA has reviewed the NRC findings at 10 CFR 51 (Table B-1) and has not identified any new and significant information that would make the NRC findings, with respect to Category 1 issues, inapplicable to DAEC. Therefore, FPL-DA adopts by reference the NRC findings for these Category 1 issues.

"NA" License Renewal Issues

NRC determined that its categorization and impact-finding definitions did not apply to Issues 60 and 92; however, FPL-DA included these issues in Table A-1. NRC noted that applicants currently do not need to submit information on Issue 60, chronic effects from electromagnetic fields (10 CFR 51). For Issue 92, environmental justice, NRC does not require information from applicants, but noted that it will be addressed in individual license renewal reviews (10 CFR 51). FPL-DA has included environmental justice demographic information in Sections 2.6.2 and 4.21.

CATEGORY 2 LICENSE RENEWAL ISSUES

NRC

> **"The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to subpart A of this part." 10 CFR 51.53(c)(3)(ii)**
>
> **"The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues…." 10 CFR 51.53(c)(3)(iii)**

NRC designated 21 issues as Category 2. Sections 4.1 through 4.21 address the Category 2 issues, beginning with a statement of the issue. Six Category 2 issues apply to operational features that DAEC does not have. In addition, four Category 2 issues apply only to refurbishment activities. If the issue does not apply to DAEC, the section explains the basis for inapplicability.

For the 11 Category 2 issues that FPL-DA has determined to be applicable to DAEC, the appropriate sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to the renewal of the operating license for DAEC and, if applicable, discuss potential mitigative alternatives in proportion to the significance of the impact. FPL-DA has identified the significance of the impacts associated with each issue as either small, moderate, or large, consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3 as follows:

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.

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

In accordance with National Environmental Policy Act (NEPA) practice, FPL-DA considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are small receive less mitigative consideration than impacts that are large).

4.1 WATER USE CONFLICTS (PLANTS WITH COOLING PONDS OR COOLING TOWERS USING MAKEUP WATER FROM A SMALL RIVER WITH LOW FLOW)

NRC

"If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3 / year (9×10^{10} m^3/year), 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. The 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)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 13

The NRC made surface water use conflicts a Category 2 issue because consultations with regulatory agencies indicate that water use conflicts are already a concern at two closed-cycle plants and may be a problem in the future at other plants. In the GEIS, NRC notes two factors that may cause water use and availability issues to become important for some nuclear power plants that use cooling towers. First, some plants equipped with cooling towers are located on small rivers that are susceptible to droughts or competing water uses. Second, consumptive water loss associated with closed-cycle cooling systems may represent a substantial proportion of the flows in small rivers (NRC 1996e).

DAEC primarily uses a closed loop cooling system with mechanical draft cooling towers to dissipate heat. River water lost to cooling tower evaporation and blowdown is replaced by makeup water pumped from the Cedar River. A portion (up to 1,500 gallons per minute [gpm]) of the makeup water is pumped from the Silurian-Devonian aquifer, thus reducing the river water withdrawal and consumptive loss to evaporation. The site's blowdown from both river and groundwater makeup is discharged to the river via a National Pollutant Discharge Elimination System (NPDES)-permitted outfall (DAEC 2005a).

Based on U.S. Geological Survey (USGS) records for water years 1903 through 2005, the annual mean flow of the Cedar River at the Cedar Rapids gauging station 20.8 river miles downstream from the site is 3,783 cubic feet per second (cfs) (Nalley et al. 2006). Records at this gauge can be considered as representative of site discharges as there is little additional inflow or outflow between the two points (DAEC 2005a). Further, the drainage area at the USGS gauging station (Nalley et al. 2006) is approximately four percent greater than the drainage area at DAEC (DAEC 2005a). The mean flow at the representative Cedar Rapids gauging station equals 1.19×10^{11} cubic feet per year, which means that the Cedar River at DAEC meets the NRC definition of a small river. Therefore, this issue applies to DAEC.

At DAEC, the circulating water system draws water from the Cedar River at a design plant operating condition of approximately 11,000 gpm (24.5 cfs). This withdrawal represents approximately 0.65 percent of the average Cedar River flow (3,783 cfs). Maximum consumptive use is less than 7,000 gpm (15.6 cfs) (AEC 1973), which is approximately 0.41 percent of the average Cedar River flow. Under low river flow conditions, FPL-DA may release water from the Pleasant Creek Reservoir for low-flow augmentation purposes at a rate equal to the consumptive use of river water at DAEC and for recreational management purposes (Moeller 2005). Because consumptive loss is minimal relative to normal river flow and it would be replaced under drought conditions, downstream flow conditions are protected.

The rates of population and industrial growth in the Cedar River basin above the DAEC site are low, and the projection of these rates does not indicate a substantial increase in water demand. Therefore, adequate supply of makeup water from the Cedar River is ensured.

Therefore, any impacts caused by DAEC makeup water withdrawal or consumptive use would be SMALL and would not warrant mitigation beyond that already provided by the Pleasant Creek Reservoir.

4.2 ENTRAINMENT OF FISH AND SHELLFISH IN EARLY LIFE STAGES (PLANTS WITH ONCE-THROUGH COOLING OR COOLING PONDS)

NRC

"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations…or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from…entrainment." 10 CFR 51.53(c)(3)(ii)(B)

"...The impacts of entrainment are small in early life stages 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..." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 25

The issue of entrainment of fish and shellfish in early life stages does not apply to DAEC because the station does not utilize once-through cooling or cooling pond heat dissipation systems. Nevertheless, the DAEC has a current NPDES permit which constitutes compliance with CWA Section 316(b).

4.3 IMPINGEMENT OF FISH AND SHELLFISH (PLANTS WITH ONCE-THROUGH COOLING OR COOLING PONDS)

NRC

"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations…or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from…impingement…." 10 CFR 51.53(c)(3)(ii)(B)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B 1, Issue 26

The issue of impingement of fish and shellfish does not apply to DAEC because the station does not utilize once-through cooling or cooling pond heat dissipation systems. Nevertheless, the DAEC has a current NPDES permit which constitutes compliance with CWA Section 316(b).

4.4 HEAT SHOCK (PLANTS WITH ONCE-THROUGH COOLING OR COOLING PONDS)

NRC

> **"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act… 316(a) variance in accordance with 40 CFR Part 125, or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock …." 10 CFR 51.53(c)(3)(ii)(B)**
>
> **"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 27**

The issue of heat shock does not apply to DAEC because the station does not utilize once-through cooling or cooling pond heat dissipation systems.

4.5 GROUNDWATER USE CONFLICTS (PLANTS USING > 100 GPM OF GROUNDWATER)

NRC

"If the applicant's plant…pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater use must be provided." 10 CFR 51.53(c)(3)(ii)(C)

"Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 33

NRC made groundwater use conflicts a Category 2 issue because, at a withdrawal rate of more than 100 gpm, a cone of depression could extend offsite. This could deplete the groundwater supply available to offsite users, an impact that could warrant mitigation. Information to ascertain includes: (1) DAEC groundwater withdrawal rate, (2) drawdown at offsite location, and (3) impact on neighboring wells.

Based on information provided in Table 2.3-2, DAEC used an annual average of approximately 1,394 gpm of groundwater from 2001 through 2005. Therefore, the issue of groundwater use conflicts applies to DAEC.

Under normal operation, two wells are used in tandem to supply the groundwater used at DAEC, while the remaining wells are maintained as backup.

In 1972, pump tests were performed (DAEC 1972) simultaneously on two shallow DAEC site production wells (PW-1 and PW-2), which were approximately 1,350 feet apart and installed to depths of 120 and 132 feet, respectively. The pump tests were monitored at three site observation wells. Production Well 1 was pumped at a rate of 730 gpm with a drawdown of approximately 17 feet. Production well 2 was pumped at a rate of 650 gpm with a drawdown of approximately 19 feet. The results of the test indicated drawdown in observation wells of approximately 3 to 7 feet. Drawdown in the production pumping wells would be greater than drawdown at other onsite or offsite locations.

Since 1972, two additional wells (B &D) have been bored and put into production, while the two original production wells were re-drilled to deeper levels and renamed (PW-1 became C and PW-2 became A). The four wells now tap into the deeper Sulirian-Devonian aquifer, rather than the shallow alluvial aquifer.

In 2001, a pump test was performed (DAEC 2001) on Well A, which had been re-drilled to a depth of 375 feet. Well A was pumped at a rate of 750 gpm and drawdown in the pumping well stabilized at 13.25 feet after approximately 30 minutes of pumping. This drawdown was less than that from the 1972 tests. Additionally, a comparison of these results with the 1972 test results would suggest that drawdown of the potentiometric surface onsite and at potential offsite locations would also have been less in 2001, and would involve a different aquifer.

Periodic pump tests have indicated that drawdown impacts have decreased during the period of the current operating permit. It is not expected that changes in operational water needs would occur during the license renewal period. Therefore, DAEC concludes that impacts from onsite and offsite groundwater use over the license renewal period would be SMALL and would not warrant mitigation.

4.6 GROUNDWATER USE CONFLICTS (PLANTS USING COOLING TOWERS WITHDRAWING MAKEUP WATER FROM A SMALL RIVER)

NRC

"If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3 / year...[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(3)(ii)(A)

"…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 on line before the time of license renewal…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 34

NRC made this groundwater use conflict a Category 2 issue because consumptive use of withdrawals from small rivers could adversely impact aquatic life, downstream users of the small river, and groundwater aquifer recharge. This is a particular concern during low-flow conditions and could create a cumulative impact due to multiple consumptive users.

The issue of groundwater use conflicts applies because DAEC withdraws makeup water from a small river, the Cedar River, which has an annual mean flow of 3,783 cfs (1.19 ×10^{11} cubic feet per year) at the USGS Cedar Rapids gauging station (Nalley et al. 2006). Records at this gauge can be considered as representative of site discharges as there is little additional inflow or outflow between the two points (DAEC 2005a). Further, the drainage area at the USGS gauging station (Nalley et al. 2006) is approximately four percent greater than the drainage area at DAEC (DAEC 2005a).

As discussed in Section 3.1, DAEC utilizes a closed loop cooling system with mechanical draft cooling towers to dissipate heat. Blowdown from the cooling towers is returned to the river via an NPDES outfall. Water lost to cooling tower blowdown and evaporation is replaced by makeup water pumped from the Cedar River.

As discussed in Section 4.1, the circulating water system draws water from the Cedar River at a design plant operating condition of approximately 11,000 gpm (24.5 cfs). DAEC's water withdrawal from the Cedar River represents approximately 0.65 percent of the average river flow (3,783 cfs). Maximum consumptive use is less than 7,000 gpm (15.6 cfs) (AEC 1973), which is approximately 0.41 percent of the average Cedar River flow. Under low river flow conditions, FPL-DA may release water from the Pleasant Creek Reservoir for low-flow augmentation purposes at a rate equal to the consumptive use of river water at DAEC (7,000 gpm) and for recreational management purposes (Moeller 2005). Thus, DAEC withdrawals have little impact on flow in the Cedar River, even during low flow conditions, and therefore have little effect on recharge to the alluvial aquifer.

Therefore, FPL-DA concludes that impacts of withdrawing water from the river on the alluvial aquifer would be SMALL and that mitigation measures would not be warranted.

4.7 GROUNDWATER USE CONFLICTS (PLANTS USING RANNEY WELLS)

NRC

"If the applicant's plant uses Ranney wells…an assessment of the impact of the proposed action on groundwater use must be provided." 10 CFR 51.53(c)(3)(ii)(C)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 35

NRC made this groundwater use conflict a Category 2 issue because large quantities of groundwater withdrawn from Ranney wells could degrade groundwater quality at river sites by induced infiltration of poor-quality river water into an aquifer.

The issue of groundwater use conflicts does not apply to DAEC because the plant does not use Ranney wells. As Section 3.1.2 describes, DAEC uses a closed cycle cooling system with cooling towers that remove makeup water from the Cedar River and discharge blowdown to the Cedar River.

4.8 DEGRADATION OF GROUNDWATER QUALITY (PLANTS USING COOLING PONDS AT INLAND SITES)

NRC

"If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided." 10 CFR 51.53(c)(3)(ii)(D)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B 1, Issue 39

NRC made degradation of groundwater quality a Category 2 issue because evaporation from closed-cycle cooling ponds concentrates dissolved solids in the water and settles suspended solids. In turn, seepage into the water table aquifer could degrade groundwater quality.

The issue of groundwater degradation does not apply to DAEC because the plant does not use cooling ponds. As Section 3.1 describes, DAEC uses a closed loop cooling system with mechanical draft cooling.

4.9 IMPACTS OF REFURBISHMENT ON TERRESTRIAL RESOURCES

NRC

The environmental report must contain an assessment of "…the impacts of refurbishment and other license renewal-related construction activities on important plant and animal habitats…." 10 CFR 51.53(c)(3)(ii)(E)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 40

"…If no important resources would be affected, the impacts would be considered minor and of small significance. If important resources could be affected by refurbishment activities, the impacts would be potentially significant…." NRC 1996e

NRC made impacts to terrestrial resources from refurbishment a Category 2 issue, because the significance of ecological impacts cannot be determined without considering site- and project-specific details (NRC 1996e). Aspects of the site and project to be ascertained are: (1) the identification of important ecological resources, (2) the nature of refurbishment activities, and (3) the extent of impacts to plant and animal habitats.

The issue of impacts of refurbishment on terrestrial resources is not applicable to DAEC because, as discussed in Section 3.2, FPL-DA has no plans for refurbishment or other license renewal-related construction activities at DAEC.

4.10 THREATENED OR ENDANGERED SPECIES

NRC

"All license renewal applicants shall assess the impact of refurbishment and other license-renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened and endangered species in accordance with the Endangered Species Act." [10 CFR 51.53(c)(3)(ii)(E)]

"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." [10 CFR Part 51, Subpart A, Appendix B, Table B-1, Issue 49]

The NRC made impacts to threatened and endangered species a Category 2 issue because the status of many species is being reviewed, and a site-specific assessment is required to determine whether any identified species could be affected by refurbishment activities or continued plant operations through the renewal period. In addition, compliance with the Endangered Species Act requires consultation with the appropriate federal agency (NRC 1996e). Information pertinent to this assessment includes: (a) actual or potential occurrence of threatened or endangered species on or in the vicinity of the DAEC site and associated transmission lines that are in the scope of DAEC license renewal, (b) impact initiators presented by continued operation of DAEC and these transmission lines that could affect threatened or endangered species that do or may occur, (c) controls established for impact initiators, and (d) industry and plant experience related to potential impacts.

Section 2.2 of this Environmental Report describes the aquatic communities at the DAEC and in the adjacent Cedar River. Section 2.4 describes terrestrial habitats at DAEC and along the associated transmission corridors. Section 2.5 discusses threatened or endangered species that occur or may occur in the vicinity of the DAEC and along FPL-DA associated transmission corridors.

With the exception of the species identified in Section 2.5, FPL-DA is not aware of any threatened or endangered terrestrial species that could occur at the DAEC or along the associated transmission corridors. Current operations of DAEC and vegetation management practices along transmission line rights-of-way are not believed to affect any listed terrestrial or aquatic species or their habitat. Furthermore, plant operations and transmission line maintenance practices are not expected to change significantly during the license renewal term. Therefore, no adverse impacts to threatened or endangered terrestrial or aquatic species from current or future operations are anticipated.

FPL-DA wrote to the Iowa Department of Natural Resources and the U.S. Fish and Wildlife Service requesting information on any listed species or critical habitats that might occur on the DAEC or along the associated transmission corridors, with particular emphasis on species that might be adversely affected by continued operation over the license renewal period. Agency responses are provided in Appendix C and indicate that license renewal is unlikely to affect any listed species as long as current vegetation management practices are followed.

As discussed in Section 3.2, FPL-DA has no plans to conduct refurbishment or construction activities at DAEC during the license renewal term. Therefore, there would be no refurbishment-related impacts to special-status species and no further analysis of refurbishment-related impacts is applicable. Furthermore, because FPL-DA has no plans to alter current operations, resource agencies contacted by FPL-DA evidenced no serious concerns about license renewal impacts. FPL-DA concludes that impacts to threatened or endangered species from license renewal would be SMALL and do not warrant mitigation.

4.11 AIR QUALITY DURING REFURBISHMENT (NONATTAINMENT AND MAINTENANCE AREAS)

NRC

> **"…If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment workforce must be provided in accordance with the Clean Air Act as amended…." 10 CFR 51.53(c)(3)(ii)(F)**
>
> **"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 50**

NRC made impacts to air quality during refurbishment a Category 2 issue because vehicle exhaust emissions could be cause for some concern, and a general conclusion about the significance of the potential impact could not be drawn without considering the compliance status of each site and the number of workers expected to be employed during an outage (NRC 1996e). Information needed would include: (1) the attainment status of the plant-site area and (2) the number of additional vehicles as a result of refurbishment activities.

Air quality during refurbishment is not applicable to DAEC because, as discussed in Section 3.2, FPL-DA has no plans for refurbishment at DAEC.

4.12 IMPACTS ON PUBLIC HEALTH OF MICROBIOLOGICAL ORGANISMS

NRC

"If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flowrate of less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided." 10 CFR 51.53(c)(3)(ii)(G)

"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." 10 CFR 51,Subpart A, Appendix B, Table B-1, Issue 57

Due to the lack of sufficient data from facilities using cooling ponds, lakes, or canals or discharging to small rivers, NRC designated impacts on public health from thermophilic organisms a Category 2 issue. Information to be determined is: (1) whether the plant discharges to a small river and (2) whether discharge characteristics (particularly temperature) are favorable to the survival of thermophilic organisms.

This issue is applicable to DAEC because the plant discharges to the Cedar River, with an average flow rate of 1.05×10^{11} to 1.19×10^{11} cubic feet per year at USGS gauging stations up- and downstream of the station (Nalley et al. 2006). It is also relevant because the Cedar River in the vicinity of DAEC is used by the public for recreation, including boating and fishing.

Organisms of concern include the enteric pathogens *Salmonella* and *Shigella*, the *Pseudomonas aeruginosa* bacterium, thermophilic Actinomycetes ("fungi"), the many species of *Legionella* bacteria, and pathogenic strains of the free-living *Naegleria* amoeba.

Bacteria pathogenic to humans have evolved to survive in the digestive tracts of mammals and accordingly have optimum temperatures of around 99°F (Joklik and Smith 1972). Many of these pathogenic microorganisms (e.g., *Pseudomonas*, *Salmonella*, and *Shigella*) are ubiquitous in nature, occurring in the digestive tracts of wild mammals and birds (and thus in natural waters), but are usually only a problem when the host is immunologically compromised. Thermophilic bacteria generally occur at temperatures from 77°F to 176°F, with maximum growth at 122°F to 140°F (Joklik and Smith 1972).

DAEC uses two mechanical draft Cooling Towers to transfer waste heat from the Circulating Water System which cools the main condensers to the atmosphere (see Section 3.1.2). Thermal modeling conducted for the Final Environmental Statement for operation of DAEC indicated that outside of a small (less than one acre) mixing zone, the plant's discharge would have a modest (0.1 to 0.5 F) effect on downstream river temperature in summer (AEC 1973).

The DAEC NPDES permit (Number 5700104, issued July 6, 2004) does not contain a discharge temperature limit, but does require monitoring of discharge (blowdown) temperatures. Blowdown temperatures (Outfall 001) are monitored daily and reported monthly to the Iowa Department of Natural Resources along with other Discharge Monitoring Report parameters. The maximum daily discharge temperature was 89 F in 2001 (July and August), 90 F in 2002 (June and July), 89 F in 2003 (July), 89 F in 2004 (July and August), and 88 F in 2005 (June and August).

Water at these temperatures could, in theory, allow limited survival of thermophilic microorganisms, but are well below the optimal temperature range for growth and reproduction of thermophilic microorganisms.

Another factor controlling the survival and growth of thermophilic microorganisms in the Cedar River is the disinfection of DAEC sewage treatment plant effluent. This reduces the likelihood that a seed source or inoculant will be introduced into the Cedar River via the DAEC discharge. In addition, DAEC chlorinates water in the circulating water system to minimize the growth of algae and other microorganisms in the system. This further reduces the likelihood that a seed source or inoculant will be introduced into the Cedar River. Water from the circulating water system is dechlorinated before being returned to the Cedar River to minimize effects on the environment.

Fecal coliform bacteria are regarded as indicators of other pathogenic microorganisms, and are the organisms normally monitored by state health agencies. The present NPDES permit for DAEC requires monitoring of fecal coliforms in sewage treatment plant effluent. During the cooling season (April 1 through October 31), samples are collected once every 3 months for fecal coliform analysis and other parameters. The DAEC NPDES permit imposes a limit of 200 fecal coliform cells (geometric average value) per 100 milliliter (ml) sample. The NPDES permit also stipulates that no more than 10 percent of samples tested may contain 1,000 cells. Based on samples taken between April 2001 and October 2005, the concentration of fecal coliforms in DAEC sewage treatment plant effluent is normally less than 2 cells per 100 ml.

Given the thermal characteristics of the Cedar River at the DAEC thermal discharge, disinfection of the cooling tower blowdown, and disinfection of sewage treatment plant effluent, FPL-DA does not expect station operations to stimulate growth or reproduction of thermophilic microorganisms.

FPL-DA has written to the Bureau of Water Supply Management of the Iowa Department of Public Health (IDPH) requesting information on any concerns IDPH may have relative to these organisms. Copies of the correspondence are included in Appendix E of this environmental report. FPL-DA, with concurrence from IDPH, is not aware of reported cases of illness caused by *Naegleria* or *Legionella* at, in the vicinity of, or downstream of the plant. Therefore, FPL-DA concludes that the impact of thermophilic organisms is SMALL and does not warrant mitigation, particularly since there is no known swimming in the area.

4.13 ELECTRIC SHOCK FROM TRANSMISSION-LINE INDUCED CURRENTS

NRC

The environmental report must contain an assessment of the impact of the proposed action on the potential shock hazard from transmission lines ". ...[i]f the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electric Safety Code for preventing electric shock from induced currents." 10 CFR 51.53(c)(3)(ii)(H)

"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." 10 CFR 51, Subpart A, Appendix B, Table B 1, Issue 59

NRC made impacts of electric shock from transmission lines a Category 2 issue because, without a review of each plant's transmission line conformance with the National Electrical Safety Code (NESC; IEEE 2006) criteria, NRC could not determine the significance of the electrical shock potential. In the case of DAEC, there have been no previous NRC or NEPA analyses of transmission-line-induced current hazards. Therefore, this section provides an analysis of the plant's transmission lines' conformance with the NESC standard. The analysis is based on computer modeling of induced current under the lines.

Objects located near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through the object to the ground. The current is called "induced" because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called "capacitively charged." A person standing on the ground and touching a vehicle or a fence receives an electrical shock due to the sudden discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including the following:

- the strength of the electric field which, in turn, depends on the voltage of the transmission line as well as its height and geometry,
- the size of the object on the ground, and
- the extent to which the object is grounded.

In 1977, the NESC adopted a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98-kilovolt alternating current to ground[1]. The clearance must limit the induced current[2] due to electrostatic effects to five milliamperes if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. By way of comparison, the setting of ground fault circuit interrupters used in residential wiring is four to six milliamperes.

As described in Section 3.1.3, there are two 345-kilovolt and four 161-kilovolt lines that were specifically constructed to distribute power from DAEC to the electric grid FPL-DA calculated the electric field strength and the induced current for each line's limiting case (i.e. that configuration along the line where the potential for current-induced shock would be greatest).

These calculations were made using the EzEMF computer code. Input parameters included the design features of the limiting-case scenario, the NESC requirement that line sag be determined at 120ºF conductor temperature, and the maximum vehicle size under the lines as a tractor-trailer truck.

The analysis determined that the 345-kilovolt and 161-kilovolt lines that connect to DAEC have the capacity to induce up to 2.06 and 1.30 milliamperes, respectively. None of the transmission lines has the capacity to induce five milliamperes in a vehicle parked beneath the lines (TtNUS 2007c). Therefore, the transmission line designs conform to the NESC provisions for preventing electric shock from induced current.

The transmission service provider's surveillance and maintenance procedures provide assurance that design ground clearances will not change. These procedures include routine aerial inspection approximately every six months, which include checks for encroachments, broken conductors, broken or leaning structures, and signs of trees burning, any of which would be evidence of clearance problems. Ground inspections conducted once every two years include examination for clearance at questionable locations, integrity of structures, and surveillance for dead or diseased trees that might fall on the transmission lines. Problems noted during any inspection are brought to the attention of the appropriate organization(s) for corrective action.

FPL's assessment under 10 CFR 51 concludes that electric shock is of SMALL significance for the DAEC transmission lines. Due to the small significance of the issue, mitigation measures are not warranted.

[1] Part 2, Rules 232C1c and 232D3c.
[2] The NESC and the GEIS use the phrase "steady-state current," whereas 10 CFR 51.53(c)(3)(ii)(H) uses the phrase "induced current." The phrases mean the same here.

4.14 HOUSING IMPACTS

NRC

The environmental report must contain "...[a]n assessment of the impact of the proposed action on housing availability…" 10 CFR 51.53(c)(3)(ii)(I)

"…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 areas with growth control measures that limit housing development…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 63

"...[S]mall impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion occurs…." (NRC 1996e, Section 4.7.1.1, pp. 4-101 to 4-102)

NRC made housing impacts a Category 2 issue because impact magnitude depends on local conditions that NRC could not predict for all plants at the time of GEIS publication (NRC 1996e). Local conditions that need to be ascertained are: (1) population categorization as small, medium, or high and (2) applicability of growth control measures.

Refurbishment activities and continued operations could result in housing impacts due to increased staffing. As described in Section 3.2, FPL-DA does not plan to perform refurbishment. FPL-DA concludes that there would be no refurbishment-related impacts to area housing and no analysis is therefore required. Accordingly, the following discussion focuses on impacts of continued operations on local housing availability.

As described in Section 2.6, DAEC is located in a high population area. As noted in Section 2.8, the area of interest is not subject to growth control measures that limit housing development. FPL-DA estimates that no additional workers would be needed to support DAEC operations during the license renewal term (Section 3.4). FPL-DA concludes that since there is no increase in staffing, no housing impacts would be experienced and, therefore, the appropriate characterization of FPL-DA license renewal housing impacts is SMALL.

4.15 PUBLIC UTILITIES: PUBLIC WATER SUPPLY AVAILABILITY

NRC

> **The environmental report must contain "…an assessment of the impact of population increases attributable to the proposed project on the public water supply." 10 CFR 51.53(c)(3)(ii)(I)**
>
> **"…An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 65**
>
> **"Impacts on public utility services are considered small if little or no change occurs in the ability to respond to the level of demand and thus there is no need to add capital facilities. Impacts are considered moderate if overtaxing of facilities during peak demand periods occurs. Impacts are considered large if existing service levels (such as quality of water and sewage treatment) are substantially degraded and additional capacity is needed to meet ongoing demands for services." (NRC, 1996e, Section 3.7.4.5, pg. 3-19)**

NRC made public utility impacts a Category 2 issue because an increased problem with water availability, resulting from pre-existing water shortages, could occur in conjunction with plant demand and plant-related population growth (NRC 1996e). Local information needed would include: (1) a description of water shortages experienced in the area and (2) an assessment of the public water supply system's available capacity.

NRC's analysis of impacts to the public water supply system considered both plant demand and plant-related population growth demand on local water resources. As stated in Section 3.4, "Employment," FPL-DA anticipates no additional employee hiring attributable to license renewal. As discussed in Section 3.2, no refurbishment is planned for DAEC and no refurbishment impacts are therefore expected.

DAEC does not use water from a municipal system (see Section 3.1); therefore, DAEC operations do not affect local public water supplies. FPL-DA has identified no changes during the DAEC license renewal term that would require the plant to use municipal water.

Because DAEC does not use municipal water and because there is no anticipated increase in employment applicable to the license renewal process, FPL-DA concludes that impacts on public water systems would be SMALL and would not require mitigation.

4.16 EDUCATION IMPACTS FROM REFURBISHMENT

NRC

The environmental report must contain "…an assessment of the impact of the proposed action on public schools (impacts from refurbishment activities only) within the vicinity of the plant…." 10 CFR 51.53(c)(3)(ii)(I)

"…Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 66

"…[S]mall impacts are associated with project-related enrollment increases of 3 percent or less. Impacts are considered small if there is no change in the school systems' abilities to provide educational services and if no additional teaching staff or classroom space is needed. Moderate impacts are associated with 4 to 8 percent increases in enrollment, and if a school system must increase its teaching staff or classroom space even slightly to preserve its pre-project level of service…. Large impacts are associated with enrollment increases greater than 8 percent…." NRC 1996e, Section 3.7.4.1

NRC made refurbishment-related impacts to education a Category 2 issue because site- and project-specific factors determine the significance of impacts (NRC 1996e). Local factors to be ascertained include: (1) project-related enrollment increases and (2) status of the student/teacher ratio.

The issue of impacts to the local education system due to refurbishment is not applicable to DAEC because, as Section 3.2 discusses, FPL-DA has identified no refurbishment needs at DAEC.

4.17 OFFSITE LAND USE

4.17.1 OFFSITE LAND USE - REFURBISHMENT

NRC

The environmental report must contain "… [a]n assessment of the impact of the proposed action on...land-use" 10 CFR 51.53(c)(3)(ii)(I)

"…Impacts may be of moderate significance at plants in low population areas…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 68

"… [I]f plant-related population growth is less than 5 percent of the study area's total population, off-site land-use changes would be small, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per square mile (2.6 km^2), and at least one urban area with a population of 100,000 or more within 80 km (50 miles)…." (NRC 1996e, Section 3.7.5, pg. 3-21)

NRC made impacts to offsite land use as a result of refurbishment activities a Category 2 issue because land use changes could be considered beneficial by some community members and adverse by others. Local conditions to be ascertained include: (1) plant-related population growth, (2) patterns of residential and commercial development, and (3) proximity to an urban area with a population of at least 100,000.

This issue is not applicable to DAEC because, as Section 3.2 "Refurbishment Activities" discusses, FPL-DA has no plans for refurbishment due to license renewal at DAEC.

4.17.2 OFFSITE LAND USE - LICENSE RENEWAL TERM

NRC

The environmental report must contain "An assessment of the impact of the proposed action on…land-use…" 10 CFR 51.53(c)(3)(ii)(I)

"…Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 69

"…[I]f plant-related population growth is less than 5 percent of the study area's total population, off-site land-use changes would be small…." (NRC 1996e, Section 3.7.5, pg. 3-21)

"…[I]f the plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land-use changes during the plant's license renewal term would be small, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development…." (NRC 1996e, Section 4.7.4.1, pg. 4-108)

NRC made impacts to offsite land use during the license renewal term a Category 2 issue, because land use changes may be perceived as beneficial by some community members and adverse by others. Therefore, NRC could not assess the potential significance of site-specific offsite land use impacts (NRC 1996e). Site-specific factors to consider in an assessment of new tax-driven land use impacts include: (1) the size of plant-related population growth compared to the area's total population, (2) the size of the plant's tax payments relative to the community's total revenue, (3) the nature of the community's existing land use pattern, and (4) the extent to which the community already has public services in place to support and guide development.

The GEIS presents an analysis of offsite land use for the renewal term that is characterized by two components: population-driven and tax-driven impacts (NRC 1996e).

Population-Related Impacts

Based on the GEIS case-study analysis, NRC concluded that all new population-driven land use changes during the license renewal term at all nuclear plants would be small. Population growth caused by license renewal would represent a "much smaller percentage" of the local area's total population than the percent change represented by operations-related growth (NRC 1996e). FPL-DA agrees with the NRC conclusion that population-driven land use impacts would be SMALL. Mitigation would not be warranted.

Tax-Revenue-Related Impacts

Determining tax-revenue-related land use impacts is a two-step process. First, the significance of the plant's tax payments on taxing jurisdictions' tax revenues is evaluated. Then, the impact of the tax contribution on land use within the taxing jurisdiction's boundaries is assessed.

Tax Payment Significance

NRC has determined that the significance of tax payments as a source of local government revenue would be large if the payments are greater than 20 percent of revenue, moderate if the payments are between 10 and 20 percent of revenue, and small if the payments are less than 10 percent of revenue (NRC 1996e).

Land Use Significance

NRC defined the magnitude of land use changes as follows (NRC 1996e):

SMALL - very little new development and minimal changes to an area's land use pattern.

MODERATE - considerable new development and some changes to land use pattern.

LARGE - large-scale new development and major changes in land use pattern.

NRC further determined that, if the plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land use changes during the plant's license renewal term would be small. This would be especially true where the community has pre-established patterns of development and has provided adequate public services to support and guide development in the past (NRC 1996e).

DAEC Tax Impacts

Table 2.7-2 provides a comparison of the total property tax revenues of all Linn County taxing authorities vs. the payments made by DAEC to these same taxing authorities. It also provides a comparison of the property tax revenue for Linn County operations vs. payments made by DAEC to support these operations. For the fiscal years 2003 through 2006, DAEC's property taxes have represented less than one percent of Linn County's (all taxing authorities) total property tax revenues and less than one percent of Linn County's (only county operations) total property tax revenues. Furthermore, as stated in Section 2.7, even though over half of the total annual tax payments made by DAEC went to the Cedar Rapids Community Schools, the payments represented a fraction (less than the 10 percent threshold established by NRC) of the school district's operating budget. Using NRC's criteria, DAEC's tax payments are of small significance to Linn County and the Cedar Rapids Community Schools.

DAEC Land Use Impacts

Land use patterns have remained largely unchanged since DAEC commenced operations. Development and population continue to be concentrated in the incorporated areas, primarily in the Cedar Rapids metropolitan area, indicating that

DAEC tax payments have had minimal influence on the land use patterns. As stated in Section 2.8, Linn County is primarily rural outside of the Cedar Rapids metropolitan area, with developed land outside of incorporated areas comprising less than 16 percent of the land. Linn County and Cedar Rapids have land use plans that designate which land parcels can be used for housing, commercial, industrial, and agricultural uses (Cedar Rapids 1999; Linn County 2003, 2006c). With these plans in place, DAEC-related land use impacts in Linn County or Cedar Rapids, if any, would be restricted to complying with the established land use policies.

Conclusion

As indicated by the assessment of DAEC's tax payments on local taxing authorities, DAEC is a small contributor (percentage-based) to the property tax revenues of Linn County and the Cedar Rapids Community Schools. License renewal would not generate additional tax revenues for Linn County or the Cedar Rapids Community Schools, but a continuation of DAEC's current tax payments would prolong the small beneficial impact on the County's revenues.

Land use patterns have remained largely unchanged since DAEC commenced operations with developed land being concentrated in the incorporated areas and more than 84 percent of the land outside of incorporated areas being undeveloped. Additionally, Linn County and Cedar Rapids have land use plans that direct growth.

Therefore, the land use impacts of DAEC's license renewal term are expected to be SMALL, and mitigation would not be warranted.

4.18 TRANSPORTATION

NRC

The environmental report must "...assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license." 10 CFR 51.53(c)(3)(ii)(J)

"…Transportation impacts…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 70

Small impacts would be associated with U.S. Transportation Research Board Level of Service A, having the following condition: "…Free flow of the traffic stream; users are unaffected by the presence of others." and Level of Service B, having the following condition: "…Stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished…." (NRC 1996e, Section 3.7.4.2)

NRC made impacts to transportation a Category 2 issue, because impact significance is determined primarily by road conditions existing at the time of license renewal, which NRC could not forecast for all facilities (NRC 1996e). Local road conditions to be ascertained are: (1) level of service conditions and (2) incremental increases in traffic associated with refurbishment activities and license renewal staff.

As described in Section 3.2, no major refurbishment is planned and no refurbishment impacts to local transportation are therefore anticipated. DAEC does not anticipate hiring any additional staff for continued operations during the renewal term. Therefore, the issue of transportation is not applicable for refurbishment and SMALL for continued operations.

4.19 HISTORIC AND ARCHAEOLOGICAL RESOURCES

NRC

The environmental report must "…assess whether any historic or archeological properties will be affected by the proposed project." 10 CFR 51.53(c)(3)(ii)(K)

"…Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archeological 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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 71

"…Sites are considered to have small impacts to historic and archeological resources if (1) the State Historic Preservation Officer (SHPO) identifies no significant resources on or near the site; or (2) the SHPO identifies (or has previously identified) significant historic resources but determines they would not be affected by plant refurbishment, transmission lines, and license-renewal-term operations and there are no complaints from the affected public about altered historic character; and (3) if the conditions associated with moderate impacts do not occur." (NRC 1996e, Section 3.7.7, pg. 3-23)

NRC made impacts to historic and archaeological resources a Category 2 issue because determinations of impacts to historic and archaeological resources are site-specific in nature, and the National Historic Preservation Act mandates that impacts must be determined through consultation with the State Historic Preservation Officer (SHPO) (NRC 1996e).

In the Final Environmental Statement for the Duane Arnold Energy Center, the Atomic Energy Commission (AEC) stated that the DAEC property had no known sites of historical significance and there were no national historic sites located in the immediate vicinity of the plant. After conferring with the State Historical Society of Iowa, the United States Department of the Interior, and the Federal Advisory Council on Historic Preservation, the AEC concluded that the construction and operation of DAEC would have no effect on cultural resources in the area (AEC 1973).

As described in Section 2.11, as of 2007, 10 properties in Benton County and 75 properties in Linn County have been listed in the National Register of Historic Places. Three of these 85 properties, Shellsburg Bridge, Chain Lakes Bridge, and Taylor-Van Note fall within a 6-mile radius of DAEC.

As discussed in Section 3.2, FPL-DA has no refurbishment plans and no refurbishment-related impacts are anticipated. FPL-DA is not aware of any historic or archaeological resources that have been affected by DAEC operations, including operation and maintenance of transmission lines. Because FPL-DA has no plans to construct additional facilities at DAEC during the license renewal term and because any land-disturbing activities that may be required would be done under the auspices of FPL-DA procedures that insure the protection of cultural resources, FPL-DA concludes that operation of generation and transmission facilities over the license renewal term would have SMALL impacts to cultural resources; hence, no mitigation would be warranted.

4.20 SEVERE ACCIDENT MITIGATION ALTERNATIVES

NRC

The environmental report must contain a consideration of alternatives to mitigate severe accidents "…if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environment assessment..." 10 CFR 51.53(c)(3)(ii)(L)

"…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…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 76

This section summarizes FPL-DA's analysis of alternative ways to mitigate the impacts of severe accidents at DAEC. A detailed description of the severe accident mitigation alternatives (SAMA) analysis is provided in Appendix F.

The term "accident" refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in the release or a potential for release of radioactive material to the environment. NRC categorizes accidents as "design basis" or "severe." Design basis accidents are those for which the risk is great enough that NRC requires plant design and construction to prevent unacceptable accident consequences. Severe accidents are those that NRC considers too unlikely to warrant design controls.

NRC concluded in its license renewal rulemaking that the unmitigated environmental impacts from severe accidents met its Category 1 criteria. However, NRC made consideration of mitigation alternatives a Category 2 issue because not all plants had completed ongoing regulatory programs related to mitigation (e.g., individual plant examinations and accident management). Site-specific information to be presented in the license renewal environmental report includes: (1) potential SAMAs; (2) benefits, costs, and net value of implementing potential SAMAs; and (3) sensitivity of analysis to changes in key underlying assumptions.

DAEC maintains a probabilistic risk assessment (PRA) model to use in evaluating the most significant risks of core damage and the resulting radiological release from the containment structures. For the SAMA analysis, FPL-DA used the DAEC PRA model output as input to an NRC-approved methodology that calculates economic costs and dose to the public from hypothesized releases from the containment structure into the environment. Then, using NRC regulatory analysis techniques, FPL-DA calculated the monetary value of the unmitigated severe accident risk for DAEC. The result represents the monetary value of the base risk of dose to the public and worker, offsite and onsite economic costs, and replacement power. This value became a cost/benefit-screening tool for potential SAMAs; a SAMA whose cost of implementation exceeded the base risk value could be rejected as being not cost-beneficial. The following list summarizes the steps of this process:

- DAEC PRA Model – Use the DAEC Internal Events PRA model as the basis for the analysis and incorporate external events contributions.

- Level 3 PRA Analysis – Use DAEC Level 1 and 2 Internal Events PRA output and site-specific meteorology, demographic, land use, and emergency response data as input in performing a Level 3 PRA using the MELCOR Accident Consequences Code System Version 2 (MACCS2).

- Baseline Risk Monetization – Use the analysis techniques specified in NEI 05-01, Revision A to calculate the monetary value of the unmitigated DAEC severe accident risk. This becomes the maximum averted cost-risk (MACR) that is possible.

- Phase I SAMA Analysis – Identify potential SAMA candidates based on the DAEC PRA, Individual Plant Examination (IPE), Individual Plant Examination for External Events (IPEEE), and documentation from the industry and NRC. Screen out Phase I SAMA candidates:

    1) that are not applicable to the DAEC design or are of low benefit in boiling water reactors (BWRs) such as DAEC.

    2) that have already been implemented at DAEC or whose benefits have been achieved at DAEC using other means.

    3) whose estimated cost exceeds the possible MACR.

- Phase II SAMA Analysis – Calculate the risk reduction attributable to each remaining SAMA candidate and compare to a more detailed cost analysis to identify the net cost-benefit. PRA insights are also used to screen SAMA candidates in this phase.

- Sensitivity Analysis – Evaluate how changes in the SAMA analysis assumptions might affect the cost-benefit evaluation.

- Conclusions – Summarize results and identify conclusions.

Using this process, FPL-DA incorporated industry, NRC, and plant-specific information to create a list of 166 SAMAs for consideration. After Phase 1 screening, 23 candidate SAMAs remained for further consideration. Phase 2 screening resulted in 2 SAMAs that are potentially cost beneficial for DAEC. Each of the 2 SAMAs candidates is described below.

Implementation of SAMA 156 would involve the addition of a T-connection and valve to the pipe connecting the Residual Heat Removal Service Water and Emergency Service

Water (RHRSW/ESW) pit to the Circulating Water pit to allow for backflow from the Circulating Water pit to the RHRSW/ESW pit. This would improve the reliability of the RHRSW/ESW system through the addition of a redundant water source.

Implementation of SAMA 166 would involve a modification to install panel modifications to allow bypass of failed Emergency Core Cooling System (ECCS) low reactor pressure permissive signals and develop emergency procedures for installation of the low reactor pressure permissive bypass. This would improve the reliability of the low pressure ECCS systems given a failure of the low reactor pressure permissives signals which was identified as a top risk contributor from the PRA model.

Neither of these SAMAs is aging-related. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR 54. FPL-DA is further evaluating these SAMA candidates and has not made any decision to implement them. Evaluation of plant risk reduction is part of an ongoing effort to improve operation at DAEC and implementation of these items will be considered as part of that effort.

4.21 ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629 (1994), directs Federal agencies in the Executive Branch to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities" on minority and low-income populations. Although an independent agency, the NRC has indicated its willingness to comply with the Executive Order.

The Council on Environmental Quality (CEQ) developed guidelines to assist Federal agencies with integration of environmental justice into the NEPA process. The guidelines are contained in CEQ's December 10, 1997, document, "Environmental Justice Guidance Under the National Environmental Policy Act." CEQ's guidance is not binding on NRC activities; however, NRC has voluntarily committed to conducting environmental justice reviews of actions under its jurisdiction and has issued a policy statement and procedural guidance. Much of CEQ's guidance has been incorporated into NRC's environmental justice procedure (NRC 2004).

The NRC procedure makes clear that if no potentially significant impacts are anticipated from the proposed action, then "...these results should be documented and the environmental justice review is complete."

FPL-DA has reviewed and adopted by reference NRC findings for Category 1 issues that FPL-DA determined are applicable to DAEC (see Section 4.0). The NRC had concluded that environmental impacts for each of these issues would be SMALL. FPL-DA has addressed each Category 2 issue and has performed required analyses for those that FPL-DA determined are applicable to DAEC (see Chapter 4 and Appendix A). For each applicable Category 2 issue, FPL-DA has concluded that the environmental impacts would be SMALL. Based on FPL-DA review, DAEC license renewal and continued operations would result in no significant impacts. Therefore, there would be no disproportionately high and adverse impacts on any member of the public, including minority and low-income populations, and mitigation would not be warranted.

5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

NRC

> **"The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." 10 CFR 51.53(c)(3)(iv)**
>
> **The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants and provides for license renewal, requiring a license renewal application that includes an environmental report (10 CFR 54.23). NRC regulations at 10 CFR 51 prescribe the environmental report content and identify the specific analyses the applicant must perform. In an effort to streamline the environmental review, NRC has resolved most of the environmental issues generically (Category 1) and only requires an applicant's analysis of the remaining issues (Category 2).**

While NRC regulations do not require an applicant's environmental report to contain analyses of the impacts of Category 1 issues, the regulations [10 CFR 51.53(c)(3)(iv)] do require that an applicant identify any new and significant information of which the applicant is aware that would negate any of the generic findings that NRC has codified or evaluated in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996e). The purpose of this requirement is to alert NRC staff to such information, so the staff can determine whether to seek the Commission's approval to waive or suspend application of the rule with respect to the affected generic analysis. NRC has explicitly indicated, however, that an applicant is not required to perform a site-specific validation of GEIS conclusions (NRC 1996g).

FPL Energy Duane Arnold, LLC (FPL-DA) expects that new and significant information would include:

- Information that identifies a significant environmental issue not covered in the GEIS and codified in the regulation, or
- Information that was not covered in the GEIS analyses of a particular environmental issue and that leads to an impact finding different from that codified in the regulation.

NRC does not define the term "significant", though for the purpose of its review, FPL-DA used guidance available in Council on Environmental Quality (CEQ) regulations. The National Environmental Policy Act authorizes CEQ to establish implementing regulations for federal agency use. NRC requires license renewal applicants to provide NRC with input, in the form of an environmental report, that NRC will use to meet National Environmental Policy Act requirements as they apply to license renewal (10 CFR 51.10). CEQ guidance provides that federal agencies should prepare environmental impact statements for actions that would significantly affect the environment (40 CFR 1502.3), focus on significant environmental issues (40 CFR 1502.1), and eliminate from detailed study issues that are not significant [40 CFR 1501.7(a)(3)]. The CEQ guidance includes a lengthy definition of "significantly" that requires consideration of the context of the action and the intensity or severity of the impact(s) (40 CFR 1508.27). FPL-DA expects that moderate or large impacts, as defined by NRC, would be significant. Chapter 4 presents the NRC definitions of “moderate” and “large” impacts.

The new and significant assessment process that FPL-DA used during preparation of this license renewal application includes:

(1) interviews with Duane Arnold Energy Center (DAEC) staff with various responsibilities including environmental, engineering, radiological waste, chemistry, industrial health and safety, communications, and operations support and with Alliant Energy Group on information related to the conclusions in the GEIS as they relate to DAEC,

(2) review of FPL-DA’s environmental management systems for how current programs manage potential impacts and/or provide mechanisms for DAEC staff to become aware of new and significant information,

(3) correspondence with state and federal regulatory agencies to determine if the agencies had concerns,

(4) review of documents related to environmental issues at DAEC and regional environs,

(5) credit for oversight provided by inspections of plant facilities and environmental monitoring operations by state and federal regulatory agencies,

(6) participation in review of other licensees’ Environmental Reports, audits, and industry initiatives, and

(7) independent review of plant-related information through FPL-DA contracts with industry experts on license renewal environmental impacts.

FPL-DA is aware of no new and significant information regarding the environmental impacts of DAEC license renewal.

6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

6.1 LICENSE RENEWAL IMPACTS

FPL Energy, LLC (FPL-DA) has reviewed the environmental impacts of renewing the Duane Arnold Energy Center (DAEC) operating license and has concluded that impacts would be small and would not require mitigation. This environmental report documents the basis for FPL-DA’s conclusion. Chapter 4 incorporates by reference U.S. Nuclear Regulatory Commission (NRC) findings for the 57 Category 1 issues that apply to DAEC, all of which have impacts that are SMALL (Appendix A, Table A-1). The rest of Chapter 4 analyzes Category 2 issues, all of which are either not applicable or have impacts that would be SMALL. Table 6.5-1 identifies the impacts that DAEC license renewal would have on resources associated with Category 2 issues.

6.2 MITIGATION

NRC

> **"The report must contain a consideration of alternatives for reducing adverse impacts…for all Category 2 license renewal issues…" 10 CFR 51.53(c)(3)(iii)**
>
> **"The environmental report shall include an analysis that considers and balances…alternatives available for reducing or avoiding adverse environmental effects…" 10 CFR 51.45(c) as incorporated by 10 CFR 51.53(c)(2) and 10 CFR 51.45(c)**

Impacts of license renewal are SMALL and would not require mitigation. Current operations include monitoring activities that would continue during the license renewal term. FPL-DA performs routine monitoring to ensure the safety of workers, the public, and the environment. These activities include the biological monitoring program, radiological environmental monitoring program, air monitoring, effluent chemistry monitoring, and effluent toxicity testing. These monitoring programs ensure that the plant's permitted emissions and discharges are within regulatory limits and any unusual or abnormal emissions/discharges would be quickly detected, mitigating potential impacts.

6.3 UNAVOIDABLE ADVERSE IMPACTS

NRC

The environmental report shall discuss any "...adverse environmental effects which cannot be avoided should the proposal be implemented..." 10 CFR 51.45(b)(2) as adopted by 10 CFR 51.53(c)(2)

This environmental report adopts by reference NRC findings for applicable Category 1 issues, including discussions of any unavoidable adverse impacts (Appendix A, Table A-1). FPL-DA examined 21 Category 2 issues and identified the following unavoidable adverse impacts of license renewal:

- The cooling tower vapor plumes are visible from offsite. This visual impact will continue during the license renewal term.
- Procedures for the disposal of sanitary, chemical, and radioactive wastes are intended to reduce adverse impacts from these sources to acceptably low levels. A small impact will occur as long as the plant is in operation. Solid radioactive wastes are a product of plant operations and long-term disposal of these materials must be considered.
- Operation of DAEC results in a very small increase in radioactivity in the air and water. However, fluctuations in natural background radiation are expected to exceed the small incremental increase in dose to the local population. Operation of DAEC also creates a very low probability of accidental radiation exposure to inhabitants of the area.
- Operation of DAEC results in consumptive use of groundwater and Cedar River water. FPL-DA has plans for low-flow augmentation during drought conditions.
- Limited numbers of adult and juvenile fish are impinged on the traveling screens at the cooling water River Intake Structure.
- Very small numbers of larval fish are entrained at the cooling water River Intake Structure.

6.4 IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

NRC

The environmental report shall discuss any "...irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented…" 10 CFR 51.45(b)(5) as adopted by 10 CFR 51.53(c)(2)

Continued operation of DAEC for the license renewal term will result in irreversible and irretrievable resource commitments, including the following:

- nuclear fuel, which is used in the reactor and is converted to radioactive waste;
- land required to dispose of spent nuclear fuel, low-level radioactive wastes generated as a result of plant operations, and solid wastes generated from normal industrial operations;
- elemental materials that will become radioactive; and
- materials used for the normal industrial operations of the plant that cannot be recovered or recycled or that are consumed or reduced to unrecoverable forms.

6.5 SHORT-TERM USE VERSUS LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

NRC

The environmental report shall discuss the "...relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity..." 10 CFR 51.45(b)(4) as adopted by 10 CFR 51.53(c)(2)

The current balance between short-term use and long-term productivity at the DAEC site was established with the decision to construct the plant. The Final Environmental Statement related to the Duane Arnold Energy Center (AEC 1973) evaluated the impacts of constructing and operating DAEC in Linn County, Iowa. Short-term use of natural resources includes land and water. Much of the 500-acre site was under cultivation before its acquisition. Approximately 100 acres were disturbed and modified by plant construction activities, and 40 acres are occupied by plant structures and related facilities. Existing transmission corridors were used when feasible, reducing the need for new right-of-way acquisition to 939 acres, the majority of which was returned to agricultural use after construction. Dredging of Cedar River due to construction of a weir, barrier wall, and discharge structures resulted in some disruption of aquatic environments in a limited area of the river. The cooling towers produced some on-site fogging and icing, particularly during winter months.

After decommissioning, many environmental disturbances would cease and some restoration of the natural habitat would occur. Thus, the "trade-off" between the production of electricity and changes in the local environment is reversible to some extent.

Experience with other experimental, developmental, and commercial nuclear plants has demonstrated the feasibility of decommissioning and dismantling such plants sufficiently to restore a site to its former use. The degree of dismantlement will take into account the intended new use of the site and a balance among health and safety considerations, salvage values, and environmental impact. However, decisions on the ultimate disposition of these lands have not yet been made. Continued operation for an additional 20 years would not increase the short-term productivity impacts described here.

TABLE 6.5-1
ENVIRONMENTAL IMPACTS RELATED TO LICENSE RENEWAL AT DUANE ARNOLD ENERGY CENTER

No.	Issue	Environmental Impact
		Surface Water Quality, Hydrology, and Use (for all plants)
13	Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	**Small.** Consumptive use represents less than one percent of the mean annual flow of the Cedar River and would have little or no effect on the Cedar River and its riparian ecological communities.
		Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)
25	Entrainment of fish and shellfish in early life stages	**Small.** Though not applicable to plants with cooling towers, DAEC has a current NPDES permit which constitutes compliance with CWA Section 316(b) requirements to provide best technology available to minimize entrainment.
26	Impingement of fish and shellfish	**Small.** Though not applicable to plants with cooling towers, DAEC has a current NPDES permit which constitutes compliance with CWA Section 316(b) requirements to provide best technology available to minimize impingement.
27	Heat shock	**Small.** Though not applicable to plants with cooling towers, DAEC discharges meet state water quality standards and have very little impact on local aquatic life.
		Groundwater Use and Quality
33	Groundwater use conflicts (potable and service water, and dewatering; plants that use > 100 gpm)	**Small.** Pump tests indicate that drawdown impacts have decreased during the period of the current operating permit and no changes in operational water needs would occur during the license renewal period.
34	Groundwater use conflicts (plants using cooling towers or cooling ponds withdrawing makeup water from a small river)	**Small.** DAEC consumptive use has little impact on flow in the Cedar River, even during low flow conditions, and therefore has little effect on recharge to the alluvial aquifer.
35	Groundwater use conflicts (Ranney wells)	**None.** This issue does not apply because DAEC does not use Ranney wells.
39	Groundwater quality degradation (cooling ponds at inland sites)	**None**. This issue does not apply because DAEC does not use cooling ponds.
		Terrestrial Resources
40	Refurbishment impacts	**None.** No impacts are expected because DAEC has no plans to undertake refurbishment.
		Threatened or Endangered Species
49	Threatened or endangered species	**Small.** Two federally-listed species are found in the general vicinity of DAEC, but neither is believed to have been affected by plant operation. FPL-DA has no plans to change plant operations and transmission line maintenance practices, and resource agencies contacted by FPL-DA that responded expressed no concerns about operation on the threatened or endangered species in the vicinity.

TABLE 6.5-1 (CONTINUED)
ENVIRONMENTAL IMPACTS RELATED TO LICENSE RENEWAL AT DAEC

No.	Issue	Environmental Impact
		Air Quality
50	Air quality during refurbishment (non-attainment and maintenance areas)	**None.** No impacts are expected because DAEC has no plans to undertake refurbishment.
		Human Health
57	Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	**Small.** The low temperatures in the Cedar River and the disinfection at the sewage treatment facility do not support the propagation of pathological microbes.
59	Electromagnetic fields, acute effects (electric shock)	**Small**. The largest modeled induced current under the DAEC lines is substantially less than the 5-milliampere limit. Therefore, the DAEC transmission lines conform to the National Electrical Safety Code provisions for preventing electric shock from induced current.
		Socioeconomics
63	Housing impacts	**Small.** NRC concluded that housing impacts would be small in medium and high population areas having no growth control measures. DAEC is located in a high population area with no growth control measures.
65	Public services: public utilities	**Small.** Excess water capacity in the region of interest is more than sufficient to handle the license renewal population growth.
66	Public services: education (refurbishment)	**None.** No impacts are expected because DAEC has no plans to undertake refurbishment.
68	Offsite land use (refurbishment)	**None.** No impacts are expected because DAEC has no plans to undertake refurbishment.
69	Offsite land use (license renewal term)	**Small.** No plant-induced changes to offsite land use are expected from license renewal. Impacts from continued operation would be positive.
70	Public services: transportation	**Small.** The capacities of area roads are more than adequate to accommodate the operations workforce. The increase in traffic flow as a result of license renewal, if any, would most likely be unnoticeable.
71	Historic and archeological resources	**Small.** License renewal would have little or no effect on historic or archaeological resources. DAEC has an excavation procedure in place to protect potential archaeological, historical, or cultural resources.
		Postulated Accidents
76	Severe accidents	**Small.** The benefit/cost analysis did not identify any cost-effective aging-related severe accident mitigation alternatives.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

NRC

> **The environmental report shall discuss "Alternatives to the proposed action.…" 10 CFR 51.45(b)(3), as adopted by reference at 10 CFR 51.53(c)(2).**
>
> **"...The report is not required to include discussion of need for power or economic costs and benefits of ... alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation...." 10 CFR 51.53(c)(2).**
>
> **"While many methods are available for generating electricity, and a huge number of combinations or mixes can be assimilated to meet a defined generating requirement, such expansive consideration would be too unwieldy to perform given the purposes of this analysis. Therefore, NRC has determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable…" (NRC 1996e).**
>
> **"…The consideration of alternative energy sources in individual license renewal reviews will consider those alternatives that are reasonable for the region, including power purchases from outside the applicant's service area...." (NRC 1996c).**

Chapter 7 evaluates alternatives to Duane Arnold Energy Center (DAEC) license renewal. The chapter identifies actions that the owners of DAEC (i.e., FPL Energy Duane Arnold, LLC [FPL-DA], Central Iowa Power Cooperative, and Corn Belt Power Cooperative) might take, and associated environmental impacts, if the U.S. Nuclear Regulatory Commission (NRC) chooses not to renew the plant's operating license. The chapter also addresses DAEC actions that the owners of DAEC have considered, but would not take, and the basis for determining that such actions would be unreasonable.

FPL-DA divided its alternatives discussion into two categories, "no-action" and "alternatives that meet system generating needs." In considering the level of detail and analysis that it should provide for each category, FPL-DA relied on the NRC decision-making standard for license renewal:

> "…the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse 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)].

FPL-DA has determined that the environmental report would support NRC decision making as long as the document provides sufficient information to clearly indicate whether an alternative would have a smaller, comparable, or greater environmental impact than the proposed action. Providing additional detail or analysis serves no function if it only brings to light additional adverse impacts of alternatives to license renewal. This approach is consistent with regulations of the Council on Environmental

Quality, which provide that the consideration of alternatives (including the proposed action) should enable reviewers to evaluate their comparative merits (40 CFR 1500-1508). Chapter 7 provides sufficient detail about alternatives to establish the basis for necessary comparisons to the Chapter 4 discussion of impacts from the proposed action.

In characterizing environmental impacts from alternatives, FPL-DA has used the same definitions of “SMALL,” “MODERATE,” and “LARGE” that are presented in the introduction to Chapter 4.

7.1 NO-ACTION ALTERNATIVE

FPL-DA uses “no-action alternative” to refer to a scenario in which NRC does not renew the DAEC operating license. Components of this alternative include replacing the generating capacity of DAEC and decommissioning the facility, as described below.

FPL-DA is a wholesale supplier of electricity in Iowa, having purchased the majority share of DAEC in January 2006 from Interstate Power and Light (IPL). As part of the sale, the previous owners entered into power purchase agreements (PPAs) with FPL-DA to purchase the output from DAEC over the remaining term of its current license (IUB 2005). During the license renewal term FPL-DA may sell DAEC’s power on the open market or may renew the PPA with IPL.

DAEC provides approximately 5.1 terawatt-hours of electricity to FPL-DA’s customers annually (EIA 2007b). Currently DAEC is the only operating nuclear plant in the state. As shown in Figures 7.2-1 and 7.2-2, DAEC provides 5.2 percent of Iowa’s total electricity capacity and 10.3 percent of its generation. FPL-DA thinks that any alternative would be unreasonable if it did not include replacing the capacity of DAEC. Replacement could be accomplished by (1) building new generating capacity, (2) purchasing power from the wholesale market, or (3) reducing power requirements through demand reduction. Section 7.2.1 describes each of these possibilities in detail, and Section 7.2.2 describes environmental impacts from feasible alternatives.

The Generic Environmental Impact Statement (GEIS) (NRC 1996e) defines decommissioning as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. NRC-evaluated decommissioning options include immediate decontamination and dismantlement, and safe storage of the stabilized and defueled facility for a period of time, followed by additional decontamination and dismantlement. Regardless of the option chosen, decommissioning must be completed within a 60-year period. Under the no-action alternative, FPL-DA would continue operating DAEC until the existing license expires, then initiate decommissioning activities in accordance with NRC requirements. The GEIS describes decommissioning activities based on an evaluation of a larger reactor (the “reference” boiling-water reactor is the 1,155-megawatt-electric [MWe] Washington Public Power Supply System Nuclear Project 2). This description is applicable to decommissioning activities that FPL-DA would conduct at DAEC.

As the GEIS notes, NRC has evaluated environmental impacts from decommissioning. NRC-evaluated impacts include: impacts of occupational and public radiation dose; impacts of waste management; impacts to air and water quality; and ecological, economic, and socioeconomic impacts. NRC indicated in the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities; Supplement 1* (NRC 2002a) that the environmental effects of greatest concern (i.e., radiation dose and releases to the environment) are substantially less than the same effects resulting from reactor operations. FPL-DA adopts by reference the NRC conclusions regarding environmental impacts of decommissioning.

FPL-DA notes that decommissioning activities and their impacts are not discriminators between the proposed action and the no-action alternative. FPL-DA will have to decommission DAEC regardless of the NRC decision on license renewal; license renewal would only postpone decommissioning for another 20 years. NRC has established in the GEIS that the timing of decommissioning operations does not substantially influence the environmental impacts of decommissioning. FPL-DA adopts by reference the NRC findings (10 CFR 51, Appendix B, Table B-1, Decommissioning) that delaying decommissioning until after the license renewal term would have SMALL environmental impacts. The discriminators between the proposed action and the no-action alternative lie within the choice of generation replacement options to be part of the no-action alternative. Section 7.2.2 analyzes the impacts from these options.

FPL-DA concludes that the decommissioning impacts under the no-action alternative would not be substantially different from those occurring following license renewal, as identified in the GEIS (NRC 1996e) and in the decommissioning generic environmental impact statement (NRC 2002a). These impacts would be temporary and would occur at the same time as the impacts from meeting system generating needs.

7.2 ALTERNATIVES THAT MEET SYSTEM GENERATING NEEDS

DAEC has a net capacity of about 610 MWe and, in 2006, generated approximately 5.1 terawatt-hours of electricity (FPL 2007b; EIA 2007b). This power, equivalent to the energy used by approximately 600,000 residential customers, would be unavailable to FPL-DA's customers in the event the DAEC operating license is not renewed. If the DAEC operating license was not renewed, the owners of DAEC would need to build new generating capacity, purchase power, or reduce power requirements through demand reduction to ensure they meet the electric power requirements of their customers.

The current mix of power generation options in Iowa is one indicator of what the owners of DAEC consider to be feasible alternatives. In 2005, electric generators in Iowa had a total generating capacity of 11,087 MWe. This capacity includes units fueled by coal (55.3 percent), natural gas (21.5 percent), oil (9.3 percent), non-hydroelectric renewables (7.5 percent), nuclear (5.2 percent), and hydroelectric (1.2 percent). In 2005, the electric industry in Iowa provided approximately 44.2 terawatt-hours of electricity. Utilization of generating capacity in Iowa was dominated by coal (77.6 percent), followed by nuclear (10.3 percent), gas (5.6 percent), non-hydroelectric renewables (4.0 percent), hydroelectric (2.2 percent), and oil (0.3 percent). Figures 7.2-1 and 7.2-2 illustrate Iowa's electric industry generating capacity and utilization, respectively. (EIA 2007c)

Comparison of generating capacity with actual utilization of this capacity indicates that coal and nuclear are used by electric generators in Iowa substantially more relative to their capacity than either oil-fired or gas-fired generation. This condition reflects the relatively low fuel cost and baseload suitability for nuclear power and coal-fired plants, and relatively higher use of gas- and oil-fired units to meet peak loads. Comparison of capability and utilization for oil and gas-fired facilities indicates a strong preference of gas firing over oil firing, indicative of higher cost and greater air emissions associated with oil firing. Energy production from renewable sources is similarly preferred from a cost standpoint, but capacity is limited and utilization can vary substantially depending on resource availability.

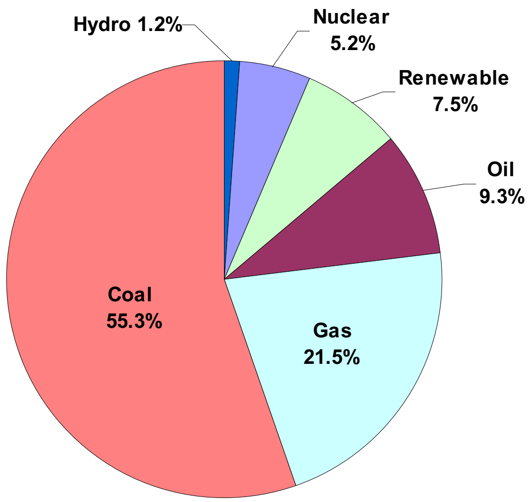


FIGURE 7.2-1. IOWA GENERATING CAPACITY BY FUEL TYPE, 2005

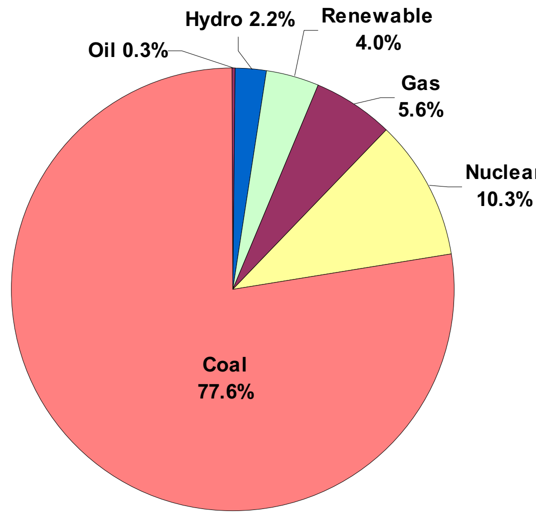


FIGURE 7.2-2. IOWA GENERATION BY FUEL TYPE, 2005

7.2.1 ALTERNATIVES CONSIDERED

Technology Choices

For the purposes of this license renewal environmental report, FPL-DA conducted evaluations of alternative generating technologies to identify candidate technologies that would be capable of replacing the net base-load capacity of the nuclear unit at DAEC.

Based on these evaluations, it was determined that feasible new plant systems to replace the capacity of the DAEC nuclear unit are limited to supercritical pulverized-coal, gas-fired combined-cycle, and new nuclear units for base-load operation. This conclusion is supported by the generation utilization information presented above that identifies coal and gas as the most heavily utilized non-nuclear generating technology in the state. FPL-DA would use natural gas as the primary fuel in its combined-cycle turbines because of the economic and environmental advantages of gas over oil. Manufacturers now have large standard sizes of combined-cycle gas turbines that are economically attractive and suitable for high-capacity base-load operation. FPL-DA chose to evaluate combined-cycle turbines in lieu of simple-cycle turbines because the combined-cycle option is more economical. The benefits of lower operating costs for the combined-cycle option outweigh its higher capital costs.

Mixture

NRC indicated in Section 8.1 of the GEIS that, while many methods are available for generating electricity and a huge number of combinations or mixes can be assimilated to meet system needs, it would be impractical to analyze all the combinations.

Therefore, NRC determined that alternatives evaluation should be limited to analysis of single discrete electrical generation sources and only those electric generation technologies that are technically reasonable and commercially viable (NRC 1996e). Consistent with the NRC determination, FPL-DA has not evaluated mixes of generating sources. The impacts from coal- and gas-fired generation presented in this chapter would bound the impacts from any combination of the two technologies.

Effects of Restructuring

Nationally, the electric power industry has been undergoing a transition from a regulated industry to a competitive market environment. Efforts to deregulate the electric utility industry began with passage of the *National Energy Policy Act* of 1992. Provisions of this act required electric utilities to allow open access to their transmission lines and encouraged development of a competitive wholesale market for electricity. The Act did not mandate competition in the retail market, leaving that decision to the states (NEI 2000).

In 1999, the Iowa Utilities Board commissioned a study on the possible outcomes of deregulating the electric utility industry in Iowa. During the 2000 legislative session, two bills that related to the restructuring of the electric industry were introduced to the Iowa General Assembly, but neither bill was acted on before the session adjourned. No new legislation has been introduced since the 2000 session. The state is continuing to monitor restructuring efforts in other jurisdictions, but is not currently pursuing further action. (FEMP 2006)

If the electric power industry in Iowa is deregulated in the future, electric retail competition would increase and electricity customers in the area would be able to choose among competing power suppliers, including those located outside the region. As such, electric generation would be based on the customers' needs and preferences, the lowest price, or the best combination of prices, services, and incentives.

Alternatives

The following sections present fossil-fuel-fired generation (Section 7.2.1.1) and advanced light water nuclear reactor (Section 7.2.1.2) as reasonable alternatives to license renewal. Section 7.2.1.3 considers the possibility of purchasing power from different electricity producers. Section 7.2.1.4 discusses reduced demand and presents the basis for concluding that it is not a reasonable alternative to license renewal. Section 7.2.1.5 discusses other alternatives that FPL-DA has determined are not reasonable and FPL-DA basis for these determinations.

7.2.1.1 Construct and Operate Fossil-Fuel-Fired Generation

FPL-DA analyzed locating hypothetical new coal- and gas-fired units at the existing DAEC site and at an undetermined green field site. FPL-DA concluded that DAEC is the preferred site for new construction because this approach would minimize environmental impacts by building on previously disturbed land and by making the most use possible of existing facilities, such as transmission lines, roads and parking areas, office buildings, and components of the cooling system. Locating hypothetical units at the existing site has, therefore, been applied to the coal- and gas-fired units.

Industry experience indicates that, although custom size units can be built, using standardized sizes is more economical. For example, standard-sized units include a gas-fired combined-cycle plant of 562.5 MWe net capacity (Chase and Kehoe 2000). Though this standard-sized unit has a capacity less than the 610 MWe DAEC net capacity, FPL-DA selected this for comparison of alternatives. The choice ensures against overestimating environmental impacts from the alternatives. The shortfall in capacity could be replaced by other methods (see Mixture in Section 7.2.1).

It must be emphasized, however, that these are hypothetical scenarios. FPL-DA does not have plans for such construction at DAEC.

Gas-Fired Generation

FPL-DA has chosen to evaluate gas-fired generation with combined-cycle turbines because the technology is mature, has relatively low capital costs, and offers low environmental effects.

FPL-DA used characteristics of available gas-fired units and other relevant resources in defining the DAEC gas-fired alternative. FPL-DA assumes that the representative plant would be located at the DAEC site, which offers potential advantages of existing infrastructure (e.g., cooling water system, transmission, roads, and technical and administrative support facilities). Table 7.2-1 presents the basic gas-fired alternative characteristics.

TABLE 7.2-1 GAS-FIRED ALTERNATIVE

Characteristic	Basis
Unit size = 562.5 MWe ISO rating net:[a]	Manufacturer's standard size gas-fired combined-cycle plant that is < DAEC net capacity – 610 MWe
Unit size = 586 MWe ISO rating gross[a]	Calculated based on 4 percent onsite power
Number of units = 1	Assumed
Fuel type = natural gas	Assumed
Fuel heating value = 1,007 Btu/ft^3	2005 value for gas used in Iowa (EIA 2006)
Fuel SO_x content = 0.00066 lb/MMBtu	(EPA 2000, Table 3.1-2a; INGAA 2000)
NO_X control = selective catalytic reduction (SCR) with steam/water injection	Best available for minimizing NO_X emissions (EPA 2000)
Fuel NOx content = 0.0109 lb/MMBtu	Typical for large SCR-controlled gas fired units with water injection (EPA 2000)
Fuel CO content = 0.00226 lb/MMBtu	Typical for large SCR-controlled gas fired units (EPA 2000)
Fuel PM_{10} content = 0.0019 lb/MMBtu	EPA 2000, Table 3.1-2a
Heat rate = 5,940 Btu/kWh	(Chase and Kehoe 2000)
Capacity factor = 0.85	Assumed based on performance of modern plants

a. The difference between "net" and "gross" is electricity consumed onsite.

Btu = British thermal unit
ft^3 = cubic foot
lb = pound
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity, and 14.696 pounds of atmospheric pressure per square inch
kWh = kilowatt hour
MM = million
MWe = megawatt-electric
NO_X = nitrogen oxides
SO_X = oxides of sulfur
PM_{10} = particulates having a diameter < 10 micron
≤ = less than or equal to

Coal-Fired Generation

NRC has routinely evaluated coal-fired generation alternatives for nuclear plant license renewal. In the GEIS Supplement for Oyster Creek Nuclear Station (NRC 2007b), NRC analyzed 600 MWe of coal-fired generation capacity. FPL-DA has reviewed the NRC analysis, considers it to be sound, and notes that it analyzed more generating capacity than the 562.5 MWe discussed in this analysis. In defining the DAEC coal-fired alternative, FPL-DA has used site- and Iowa-specific data and has applied the NRC analysis, where appropriate.

Table 7.2-2 presents the basic coal-fired alternative emission control characteristics. FPL-DA based its emission control technology and percent control assumptions on alternatives that the U.S. Environmental Protection Agency (EPA) has identified as being available for minimizing emissions (EPA 1998). FPL-DA assumes that the representative plant would be located at the DAEC site, which offers potential advantages of existing infrastructure (e.g., cooling water system, transmission, roads, and technical and administrative support facilities). For the purposes of analysis, FPL-DA has assumed that coal and lime (calcium oxide) would be delivered to DAEC via an existing rail spur.

TABLE 7.2-2 COAL-FIRED ALTERNATIVE

Characteristic	Basis
Unit size = 562.5 MWe ISO rating net[a]	Calculated to be < DAEC net capacity – 610 MWe
Unit size = 598 MWe ISO rating gross[a]	Calculated based on 6 percent onsite power
Number of units = 1	Assumed
Boiler type = tangentially fired, dry-bottom supercritical steam system	Minimizes nitrogen oxides emissions (EPA 1998)
Fuel type = bituminous, pulverized coal	Typical for coal used in Iowa
Fuel heating value = 8,668 Btu/lb	2005 value for coal used in Iowa (EIA 2006)
Fuel ash content by weight = 5.19 percent	2005 value for coal used in Iowa (EIA 2006)
Fuel sulfur content by weight = 0.42 percent	2005 value for coal used in Iowa (EIA 2006)
Uncontrolled NO_x emission = 10 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998)
Uncontrolled CO emission = 0.5 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998)
Heat rate = 8,568 Btu/kWh	Typical for coal-fired, single-cycle supercritical steam turbines (Perrin Quarles 2001)
Capacity factor = 0.85	Typical for large coal-fired units
SO_x control = Wet scrubber - lime (95 percent removal efficiency)	Best available for minimizing SO_x emissions (EPA 1998)
NO_x control = low NO_x burners, overfire air and selective catalytic reduction (95 percent reduction)	Best available and widely demonstrated for minimizing NO_x emissions (EPA 1998)
Particulate control = fabric filters (baghouse-95 percent removal efficiency)	Allowable bag house efficiency from Iowa DNR (IDNR 2007d)

a. The difference between “net” and “gross” is electricity consumed onsite.

Btu = British thermal unit
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity, and 14.696 pounds of atmospheric pressure per square inch
kWh = kilowatt hour
NSPS = New Source Performance Standard
lb = pound
MWe = megawatt-electric
NO_x = nitrogen oxides
SO_x = oxides of sulfur
≤ = less than or equal to

7.2.1.2 Construct and Operate New Nuclear Reactor

Since 1997, the NRC has certified four new standard designs for nuclear power plants under 10 CFR 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10 CFR 52, Appendix A), the System 80+ Design (10 CFR 52, Appendix B), the AP600 Design (10 CFR 52, Appendix C), and the AP1000 Design (10 CFR 52, Appendix D). All of these plants are light-water reactors. NRC evaluated 640 MWe of new nuclear generation capacity as an alternative for the Oyster Creek Nuclear Station (NRC 2007b). FPL-DA has reviewed the NRC analysis, believes it to be sound, and notes that it analyzed more generating capacity than the 562.5 MWe discussed in this analysis. In defining the DAEC new nuclear reactor alternative, FPL-DA has used site- and Iowa-specific data and has scaled from the NRC analysis, where appropriate.

7.2.1.3 Purchase Power

FPL-DA is a wholesale supplier of electric power in Iowa and sells all of its electricity to IPL under long term PPAs (IUB 2005). Therefore, it would not be economical for FPL-DA to purchase power on the market and resell it, nor does it have any requirement to do so. Therefore, FPL-DA does not consider such power purchases feasible.

7.2.1.4 Demand-Side Management

Demand-side management (DSM) is a utility program that seeks to reduce consumer energy consumption through conservation, efficiency measures, and load management. DSM efforts can help minimize environmental effects by avoiding the construction and operation of new generation facilities. The impacts that would result from the construction of the proposed facility, or from the supply of the additional power through other means, would be avoided if DSM were sufficient to reduce the need for additional power.

Because FPL-DA is a merchant generator and does not have a retail customer base in Iowa, it does not have demand-side management programs in Iowa. Also, as an operator of a base-load plant with PPAs to sell all its electricity, FPL-DA has no financial interest in reducing demand. Therefore, DSM is not considered a reasonable alternative to renewal of the DAEC operation license.

7.2.1.5 Other Alternatives

This section identifies generating alternatives that FPL-DA has determined are not reasonable and the FPL-DA bases for these determinations. FPL-DA accounted for the fact that DAEC is a base-load generator and that any feasible alternative to DAEC would also need to be able to generate base-load power. In performing this evaluation, FPL-DA relied heavily upon NRC's GEIS (NRC 1996e).

Wind

Wind power, by itself, is not suitable for large base-load generation. As discussed in Section 8.3.1 of the GEIS, wind has a high degree of intermittence, and average annual capacity factors for wind plants are relatively low (less than 30 percent). Wind power, in conjunction with energy storage mechanisms, might serve as a means of providing base-load power. However, current energy storage technologies are too expensive for wind power to serve as a large base-load generator.

Based on National Renewable Energy Laboratory 2005 estimates, Iowa's technical potential (the upper limit of renewable electricity production and capacity that could be brought online, without regard to cost, market acceptability, or market constraints) is nearly 155,000 MWe of wind energy capacity (NREL 2005). The full exploitation of wind energy is constrained by a variety of factors including land availability and land-use patterns, surface topography, infrastructure constraints, environmental constraints, wind turbine capacity factor, wind turbine availability, and grid availability. When these constraints on wind energy development are considered, the achievable wind energy potential is expected to fall in the range of 20-40 percent of technical potential estimates or 31,000 – 62,000 MWe.

By September of 2006, a total of 837 MWe of wind energy capacity had been developed in Iowa. This ranks Iowa third in the nation in terms of total installed wind capacity. Projected new capacity in various stages of review within Iowa includes an additional 836 MWe of wind energy. Most of these existing and proposed wind farms are located in north or northwest Iowa where the best wind resources are located. (IUB 2006)

Wind farms, the most economical wind option, generally consist of 10-50 turbines in the 1-3 MWe range. Estimates based on existing installations indicate that a utility-scale wind farm would occupy about 50 acres per MWe of installed capacity. The amount of land actually occupied by the wind farm facilities is 3 to 5 percent of the wind farm's total acreage. (McGowan and Connors 2000) Therefore, the replacement of DAEC generating capacity with wind power, assuming ideal wind conditions and a wind farm capacity factor of 35 percent, would require about 130 square miles with a physical footprint of 2,537 acres (4 square miles). Based on the amount of land needed to replace DAEC, the wind alternative would require a large greenfield site, which would result in a large environmental impact. Additionally, wind plants have aesthetic impacts, generate noise, and can harm flying birds and bats.

The scale of this technology is too small to directly replace a power plant of the size of DAEC, capacity factors are low (30 to 40 percent), and the land requirement (130 square miles) is large. Therefore, FPL-DA has concluded that wind power is not a reasonable alternative to DAEC license renewal.

Solar

By its nature, solar power is intermittent. In conjunction with energy storage mechanisms, solar power might serve as a means of providing base-load power.

However, current energy storage technologies are too expensive to permit solar power to serve as a large base-load generator. Even without storage capacity, solar power technologies (photovoltaic and thermal) cannot currently compete with conventional nuclear or fossil-fueled technologies in grid-connected applications, due to high costs per kilowatt of capacity (NRC 1996e).

The average amount of solar radiation suitable for photovoltaic collection that falls on Iowa annually ranges from 4.5 to 5.0 kilowatt hours per square meter per day. The solar radiation suitable for thermal collection increases across the state from east to west with a range of 3.0 to 4.5 kilowatt hours per square meter per day (EERE 2006a). Estimates based on existing installations indicate that utility-scale plants would occupy about 7.4 acres per MWe for photovoltaic and 4.9 acres per MWe for solar thermal systems (DOE 2004). Utility-scale solar plants have only been used in regions, such as southern California, that receive high concentrations (average 5.5 to 7.5 kilowatt hours per square meter per day for both photovoltaic and solar thermal systems) of solar radiation (EERE 2006b). FPL-DA believes that a utility-scale solar plant located in Iowa would occupy about 9.3 acres per MWe for photovoltaic and 9.1 acres per MWe for solar thermal systems and have capacity factors of 24 and 32 percent respectively. Therefore, replacement of the generating capacity of a baseload plant such as DAEC with solar power would require dedication of about 23,000 acres (36 square miles) for photovoltaic and 17,000 acres (26 square miles) for solar thermal systems. The existing DAEC site is approximately 500 acres (less than 1 square mile). Neither type of solar electric system would fit on the DAEC site nor both would have large environmental impacts at a greenfield site.

FPL-DA has concluded that due to the high cost, limited availability of sufficient incident solar radiation, and amount of land needed, solar power is not a reasonable alternative to DAEC license renewal.

Hydropower

According to the U.S. Hydropower Resource Assessment for Iowa, there are no single sites in Iowa that would be environmentally suitable for a large hydroelectric facility. The total of all the undeveloped hydropower potential in the entire state equals 305 MWe. This capacity is spread over 79 different locations; the majority of the potential capacity is at sites with some type of damming structure but without developed hydropower generating capability (Francfort 1995). To develop this hydropower would require a large amount of resources spread over many different locations. In addition this potential capacity is considerably less than needed to replace the 610 MWe capacity of DAEC. As the GEIS points out in Section 8.3.4, hydropower's proportion of United States generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern over flooding, destruction of natural habitat, and alteration of natural river courses.

The GEIS estimates land use of 1,553 square miles per 1,000 MWe for hydroelectric power. Based on this estimate, replacement of DAEC generating capacity would require flooding approximately 919 square miles, resulting in a very large impact on land use. Further, operation of a hydroelectric facility would alter aquatic habitats above and below the dam, which would impact existing aquatic communities.

FPL-DA has concluded that due to the lack of suitable sites in Iowa for a large hydroelectric facility and the amount of land needed (approximately 919 square miles) hydropower is not a reasonable alternative to DAEC license renewal.

Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC 1996e), geothermal plants might be located in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. Therefore, because there are no high-temperature geothermal sites in Iowa, FPL-DA concludes that geothermal is not a reasonable alternative to DAEC license renewal.

Wood Energy

As discussed in the GEIS (NRC 1996e), the use of wood waste to generate electricity is largely limited to those states with significant wood resources. The pulp, paper, and paperboard industries in states with adequate wood resources generate electric power by consuming wood and wood waste from the mills for energy. This produces a benefit from the use of waste materials that could otherwise represent a disposal problem.

National Renewable Energy Laboratory (NREL 2005) estimates the technical potential of biomass residues to be about 1675 MWe, with 90 percent produced from crop residues. This total does not include residues already used except wood mill residues most of which are already being used. Additionally, this technical potential does not consider the economic viability of using these resources for electricity generation.

The costs of using wood waste as a fuel are highly variable. Costs can be very low if they are a byproduct of another process, as in the case with mill residues. Costs become higher if the wood must be collected and transported, as in the case with crop residues. Crop residues would be an inadequate fuel source for base-load applications because of it would be difficult to harvest, haul, store and handle. Wood has a low heat content that makes it unattractive for base-load applications.

Further, as discussed in Section 8.3.6 of the GEIS (NRC 1996e), construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on a smaller scale. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and ash waste disposal. Additionally, operation of wood-fired plants has environmental impacts, including impacts on the aquatic environment and air.

FPL-DA has concluded that due to lack of an environmental advantage, low heat content, handling difficulties, and high transportation costs, wood energy is not a reasonable alternative to DAEC license renewal.

Municipal Solid Waste

As discussed in Section 8.3.7 of the GEIS (NRC 1996e), the initial capital costs for municipal solid waste plants are greater than comparable steam turbine technology at wood-waste facilities. This is due to the need for specialized waste separation and handling equipment.

The decision to burn municipal solid waste to generate energy is usually driven by the need for a landfill alternative, rather than by energy considerations. Although the amount of waste entering landfills is likely to continue increasing in the near term, it is unlikely that many landfills will begin converting waste to energy because of unfavorable economics, particularly the decline of electricity prices.

Estimates in the GEIS suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal). Some of these impacts would be moderate, but still larger than the environmental effects of DAEC license renewal.

FPL-DA has concluded that, due to the high costs and lack of environmental advantages, burning municipal solid waste to generate electricity is not a reasonable alternative to DAEC license renewal.

Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), gasifying energy crops (including wood waste), and utilizing the methane from biodegradation of landfill or livestock waste. As discussed in the GEIS, none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant such as DAEC.

Further, estimates in the GEIS suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air). These systems also have large impacts on land use, due to the acreage needed to grow the energy crops.

FPL-DA has concluded that, due to the high costs and lack of environmental advantage, burning other biomass-derived fuels is not a reasonable alternative to DAEC license renewal.

Petroleum

Iowa has a few petroleum oil-fired power plants and from 1990 to 2005 the percentage share of power generated by oil-fired electricity plants in the state increased from 0.18 percent to 0.34 percent (EIA 2007c).

Oil-fired generation represents the smallest portion of the overall generation mix in Iowa and is more expensive than nuclear, gas-, or coal-fired generation. Future increases in petroleum prices are expected to make oil-fired generation increasingly more expensive than gas- or coal-fired generation. Also, construction and operation of an oil-fired plant would have environmental impacts. Based on Section 8.3.11 of the GEIS (NRC 1996e), building an oil-fired plant with a net capacity equal to DAEC would require approximately 70 acres. Operation of oil-fired plants would have aquatic and air impacts similar to those from a coal-fired plant.

FPL-DA has concluded that, due to the high costs and lack of obvious environmental advantage, oil-fired generation is not a reasonable alternative to DAEC license renewal.

Fuel Cells

Fuel cell power plants are in the initial stages of commercialization. While more than 810 large stationary fuel cell systems have been built and operated worldwide, the global stationary fuel cell electricity generating capacity in 2006 was only 105 MWe (FCT 2006). In addition, the largest stationary fuel cell power plant built was only 11 MWe (FCT 2003). Recent estimates suggest that, in order to be profitable, product costs need to be in the range of $2,000 to $4,000 per kW depending on local electricity and fuel prices, However, the current large stationery fuel cell designs are approximately $4,300 per kW (FCT 2006). FPL-DA thinks that this technology has not matured sufficiently to support production for a facility the size of DAEC. FPL-DA has concluded that, due to cost and production limitations, fuel cell technology is not a reasonable alternative to DAEC license renewal.

Delayed Retirement

As the NRC noted in the GEIS (NRC 1996e), extending the lives of existing non-nuclear generating plants beyond the time they were originally scheduled to be retired represents another potential alternative to license renewal. FPL-DA is unaware of any retired plants or plans to retire any plants in Iowa.

Nationally, fossil plants slated for retirement tend to be ones that are old enough to have difficulty in meeting today's restrictions on air contaminant emissions. In the face of increasingly stringent restrictions, delaying retirement in order to compensate for a plant the size of DAEC would appear to be unreasonable without major construction to upgrade or replace plant components. FPL-DA concludes that the environmental impacts of such a scenario are bounded by its coal- and gas-fired alternatives. For these reasons, the delayed retirement of non-nuclear generating units is not considered a reasonable alternative to DAEC license renewal.

7.2.2 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This section evaluates the environmental impacts of alternatives that FPL-DA has determined to be reasonable alternatives to DAEC license renewal: gas-fired generation, coal-fired generation, and a new nuclear plant.

7.2.2.1 Gas-Fired Generation

NRC evaluated environmental impacts from gas-fired generation alternatives in the GEIS, focusing on combined-cycle plants. Section 7.2.1.1 presents FPL-DA's reasons for defining the gas-fired generation alternative as a combined-cycle plant on the DAEC site.

In the GEIS Supplement for Oyster Creek Nuclear Station (NRC 2007b), NRC evaluated the environmental impacts of constructing and operating two 300 MWe combined-cycle, gas-fired units as an alternative to a nuclear power plant license renewal. FPL-DA has reviewed the NRC analysis, believes it to be sound, and notes that it analyzed more generating capacity than the 562.5 MWe of net power discussed in this analysis. In defining the DAEC gas-fired alternative, FPL-DA has used site- and Iowa-specific data and has scaled from the NRC analysis, where appropriate.

Air Quality

Natural gas is a relatively clean-burning fossil fuel, but the emissions from an electric generating plant would be an issue of concern. Natural gas primarily emits nitrogen oxides (NO_x), a regulated pollutant, during combustion. A natural gas-fired plant would also emit small quantities of sulfur oxides (SO_x), particulate matter, and carbon monoxide, all of which are regulated pollutants. Control technology for gas-fired turbines focuses on NO_x emissions. FPL-DA estimates the gas-fired alternative emissions to be as follows:

- SO_x = 9 tons per year
- NO_x = 141 tons per year
- Carbon monoxide = 29 tons per year
- Filterable Particulates = 61 tons per year (all particulates are PM2.5)

In 2005, Iowa was ranked as the 20th largest emitter of sulfur dioxide nationally (EIA 2007c). The acid rain requirements of the Clean Air Act Amendments capped the nation's SO_2 emissions from power plants. Each company with fossil-fuel-fired units was allocated SO_2 allowances. To be in compliance with the Act, the companies must hold enough allowances to cover their annual SO_2 emissions. FPL-DA would need to obtain SO_2 credits to operate a fossil-fuel-burning plant at the DAEC site.

While gas-fired turbine emissions are less than coal-fired boiler emissions, and regulatory requirements are less stringent, they are still substantial. FPL-DA concludes that emissions from the gas-fired alternative at DAEC would noticeably alter local air quality, but would not destabilize regional resources (i.e., air quality). Air quality impacts would therefore be MODERATE.

Waste Management

Due to the clean nature of natural gas, the solid waste generated (e.g., ash) from this type of facility would be minimal. There would be a small amount of solid waste from spent selective catalytic reduction (SCR) catalyst used for NO_x control. The SCR process for a 2,400 MWe plant would generate approximately 1,500 cubic feet of spent catalyst per year (NRC 2002b). Based on this estimate, a 562.5 MWe plant would generate approximately 350 cubic feet of spent catalyst per year. FPL-DA concludes that gas-fired generation waste management impacts would be SMALL.

Other Impacts

Land-use impacts from gas-fired units on DAEC would be less than those from the existing plant. Reduced land requirements, due to a smaller facility footprint, would reduce impacts to ecological, aesthetic, and cultural resources. The ability to construct the gas-fired alternative on the existing DAEC site would reduce construction-related impacts. Water usage for a similar sized gas-fired plant would likely be the same magnitude or less than DAEC. A smaller workforce could have adverse socioeconomic impacts. Human health effects associated with air emissions would be of concern. Aquatic biota losses due to cooling water withdrawals would be offset by the concurrent shutdown of the nuclear generators.

A new gas pipeline would be required for the gas turbine generators in this alternative. To the extent practicable, FPL-DA would route the pipeline along existing, previously disturbed, rights-of-way to minimize impacts. Approximately 15 miles of new pipeline construction would be required to connect DAEC to an existing pipeline near the plant (Bodine 2003). A 20-inch diameter pipeline would necessitate a 75-foot-wide corridor, resulting in the disturbance of as much as 136 acres. FPL-DA estimates that 24 acres would be needed for a plant site; this much previously disturbed acreage is available at DAEC, reducing loss of terrestrial habitat. Aesthetic impacts, erosion and sedimentation, fugitive dust, and construction debris impacts would be noticeable, but SMALL. FPL-DA estimates a peak construction and average workforce of 361 and 146, respectively. Consequently, socioeconomic impacts of construction would be SMALL. However, FPL-DA estimates a workforce of 20 persons for gas operations and this reduction in work force would result in adverse socioeconomic impacts. FPL-DA concludes these impacts would be MODERATE and would be mitigated by the site's proximity to the Cedar Rapids and Waterloo metropolitan areas.

Impacts to aquatic resources and water quality would be similar to, but smaller than, the impacts of DAEC, due to the plant's use of the existing cooling water system that withdraws from and discharges to Cedar River, and would be offset by the concurrent shutdown of DAEC. The additional stacks and boilers would increase the visual impact of the existing site. Impacts to cultural resources would be unlikely, due to the previously disturbed nature of the site.

FPL-DA estimates that other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these other impacts, mitigation would not be warranted beyond that previously mentioned.

7.2.2.2 Coal-Fired Generation

NRC evaluated environmental impacts from coal-fired generation alternatives in the GEIS (NRC 1996e). NRC concluded that construction impacts could be substantial, due in part to the large land area required (which can result in natural habitat loss) and the large workforce needed. NRC pointed out that siting a new coal-fired plant where an existing nuclear plant is located would reduce many construction impacts. NRC identified major adverse impacts from operations as human health concerns associated with air emissions, waste generation, and losses of aquatic biota due to cooling water withdrawals and discharges.

The coal-fired alternative that FPL-DA has defined in Section 7.2.1.1 would be located at DAEC.

Air Quality

A coal-fired plant would emit SO_x, NO_x, particulate matter, and carbon monoxide, all of which are regulated pollutants. As Section 7.2.1.1 indicates, FPL-DA has assumed a plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. FPL-DA estimates the coal-fired alternative emissions to be as follows:

- SO_x = 879 tons per year
- NO_x = 551 tons per year
- Carbon monoxide = 551 tons per year
- PM_{10} (particulates having a diameter of less than 10 microns) = 571 tons per year
- $PM_{2.5}$ (particulates having a diameter of less than 2.5 microns) = 57 tons per year

The Section 7.2.2.1 discussion of regional air quality is applicable to the coal-fired generation alternative. In addition, NRC noted in the GEIS that adverse human health effects from coal combustion have led to important federal legislation in recent years and that public health risks, such as cancer and emphysema, have been associated with coal combustion. NRC also mentioned global warming and acid rain as potential impacts. FPL-DA concludes that federal legislation and large scale concerns, such as global warming and acid rain, are indications of concerns about destabilizing important attributes of air resources. However, SO_2 emission allowances, low NO_x burners, overfire air, fabric filters or electrostatic precipitators, and scrubbers are regulator-imposed mitigation measures. As such, FPL-DA concludes that the coal-fired alternative would have MODERATE impacts on air quality; the impacts would be noticeable and greater than those of the gas-fired alternative, but would not destabilize air quality in the region.

Waste Management

FPL-DA concurs with the GEIS assessment that the coal-fired alternative would generate substantial amounts of solid waste. The coal-fired plant would annually consume approximately 2,200,000 tons of coal with an ash content of 5.19 percent. After combustion, approximately 40 percent of this ash, 46,400 tons per year, would be marketed for beneficial reuse (ACAA 2005). The remaining ash, approximately 66,800 tons per year, would be collected and disposed of onsite. In addition, approximately 22,700 tons of scrubber sludge would be disposed of onsite each year. This is based on an annual limestone usage of nearly 28,800 tons and a recycling rate of approximately 34 percent (ACAA 2005). FPL-DA estimates that ash and scrubber waste disposal over a 40-year plant life would require approximately 54 acres (2,371,600 square feet). While only half this waste volume and acreage would be attributable to the 20-year license renewal period alternative, the total numbers are pertinent as a cumulative impact.

FPL-DA contends that, with proper siting and current waste management and monitoring practices, waste disposal would not destabilize any resources. There would be space within the DAEC property for this disposal. After closure of the waste site and revegetation, the land would be available for other uses. For these reasons, FPL-DA contends that waste disposal for the coal-fired alternative would have MODERATE impacts; the impacts of increased waste disposal would be noticeable, but would not destabilize any important resource, and further mitigation would be unwarranted.

Other Impacts

FPL-DA estimates that construction of the powerblock and coal storage area would affect approximately 96 acres of land and associated terrestrial habitat. Because most of this construction would be on previously disturbed land, impacts at the DAEC site would be SMALL to MODERATE, but would be somewhat less than the impacts of using a greenfield site. Upgrades to an existing rail spur would be required for coal and lime deliveries under this alternative. Visual impacts would be consistent with the industrial nature of the site. As with any large construction project, some erosion and sedimentation and fugitive dust emissions could be anticipated, but would be minimized by using best management practices. Debris from clearing and grubbing could be disposed of onsite. FPL-DA estimates a peak construction and average workforce of 984 and 532 persons, respectively. Socioeconomic impacts from the construction workforce would be SMALL, because worker relocation would not be expected due to the site’s proximity to the Cedar Rapids metropolitan area. FPL-DA estimates an operational workforce of 69 persons for the coal-fired alternative and this reduction in workforce would result in adverse socioeconomic impacts. FPL-DA contends these impacts would be MODERATE and would be mitigated by DAEC's proximity to the Cedar Rapids and Waterloo metropolitan areas.

Impacts to aquatic resources and water quality would be similar to impacts of DAEC, due to the plant's use of the existing cooling water system, and would be offset by the concurrent shutdown of DAEC. The additional stacks, boilers, and rail deliveries would increase the visual impact of the existing site. Impacts to cultural resources would be unlikely, due to the previously disturbed nature of the site.

FPL-DA estimates that other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these other impacts, mitigation would not be warranted beyond that previously mentioned.

7.2.2.3 New Nuclear Reactor

As discussed in Section 7.2.1.2, under the new nuclear reactor alternative FPL-DA would construct and operate a single unit nuclear plant using one of the four NRC certified standard designs for nuclear power plants.

Air Quality

Air quality impacts would be minimal. Air emissions are primarily from non-facility equipment and diesel generators and are comparable to those associated with the continued operation of DAEC. Overall, emissions and associated impacts would be considered SMALL.

Waste Management

High level radioactive wastes would be similar to those associated with the continued operation of DAEC. Low level radioactive waste impacts from a new nuclear plant would be slightly less, but similar to the continued operation of DAEC. The overall impacts are characterized as SMALL.

Other Impacts

FPL-DA estimates that construction of the reactor and auxiliary facilities would affect approximately 320 to 620 acres of land and associated terrestrial habitat. Because most of this construction would be on previously disturbed land, impacts at the DAEC site would be SMALL to MODERATE. For the purposes of analysis, FPL-DA has assumed that the existing rail line would be used for reactor vessel and other deliveries under this alternative. Visual impacts would be consistent with the industrial nature of the site. As with any large construction project, some erosion and sedimentation and fugitive dust emissions could be anticipated, but would be minimized by using best management practices. Debris from clearing and grubbing could be disposed of onsite.

FPL-DA estimates a peak construction work force of 1,600 persons. The surrounding communities would experience moderate to large demands on housing and public services. After construction, the communities would be impacted by the loss of jobs as construction workers moved on. Long-term job opportunities would be comparable to continued operation of DAEC; therefore FPL-DA concludes that the socioeconomic impacts during operation would be SMALL.

Impacts to aquatic resources and water quality would be similar to impacts of DAEC, due to the plant's use of the existing cooling water system that withdraws from and discharges to Cedar River, and would be offset by the concurrent shutdown of DAEC.

FPL-DA estimates that other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these other impacts, mitigation would not be warranted beyond that previously mentioned.

8.0 COMPARISON OF ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL WITH THE ALTERNATIVES

NRC

"To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form..." 10 CFR 51.45(b)(3) as adopted by 51.53(c)(2)

Chapter 4 analyzes environmental impacts of Duane Arnold Energy Center (DAEC) license renewal and Chapter 7 analyzes impacts from renewal alternatives. Table 8-1 summarizes environmental impacts of the proposed action (license renewal) and the alternatives, for comparison purposes. The environmental impacts compared in Table 8-1 are those that are either Category 2 issues for the proposed action, license renewal, or are issues that the Generic Environmental Impact Statement (GEIS) (NRC 1996e) identified as major considerations in an alternatives analysis. For example, although the U. S. Nuclear Regulatory Commission (NRC) concluded that air quality impacts from the proposed action would be small (Category 1), the GEIS identified major human health concerns associated with air emissions from alternatives (Section 7.2.2). Therefore, Table 8-1 compares air impacts among the proposed action and the alternatives. Table 8-2 is a more detailed comparison of the alternatives.

TABLE 8.0-1
IMPACTS COMPARISON SUMMARY

		No-Action Alternative			
Impact	Proposed Action (License Renewal)	Base (Decommissioning)	With Coal-Fired Generation	With Gas-Fired Generation	With New Nuclear Generation
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL
Air Quality	SMALL	SMALL	MODERATE	MODERATE	SMALL
Ecological Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Threatened or Endangered Species	SMALL	SMALL	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL	MODERATE	SMALL	SMALL
Socioeconomics	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Waste Management	SMALL	SMALL	MODERATE	SMALL	SMALL
Aesthetics	SMALL	SMALL	SMALL	SMALL	SMALL
Cultural Resources	SMALL	SMALL	SMALL	SMALL	SMALL

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3.

TABLE 8.0-2
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative		
		With Coal-Fired Generation	With Gas-Fired Generation	With New Nuclear Generation
Alternative Descriptions				
DAEC license renewal for 20 years, followed by decommissioning	Decommissioning following expiration of current DAEC license. Adopting by reference, as bounding DAEC decommissioning, GEIS description (NRC 1996e, Section 7.1)	New construction at the DAEC site.	New construction at the DAEC site.	New construction at the DAEC site
		Use existing rail spur	Construct up to 15 miles of gas pipeline in a 75-foot-wide corridor, disturbing as much as 136 acres. May require upgrades to existing pipelines.	Use existing rail spur for delivery of reactor vessel and other large equipment during construction.
		Use existing switchyard and transmission lines	Use existing switchyard and transmission lines	Use existing switchyard and transmission lines
		One 562.5-MW (net) tangentially-fired, dry bottom unit; capacity factor 85%	One 562.5-MW (net) combined-cycle turbine; capacity factor 85%	
		Existing DAEC intake/ discharge canal system	Existing DAEC intake/ discharge canal system	Existing DAEC intake/ discharge canal system
		Pulverized bituminous coal, 8,668 Btu/pound; 8,568 Btu/kWh; 5.19% ash; 0.42% sulfur; 10 lb/ton nitrogen oxides; 2,202,157 tons coal/yr	Natural gas, 1,007 Btu/ft^3; 5,940 Btu/kWh; 0.00066 lb sulfur/MMBtu; 0.0109 lb NO_x/MMBtu; 25,735,422,356 ft^3 gas/yr	
		Low NO_x burners, overfire air and selective catalytic reduction (95% NO_x reduction efficiency).	Selective catalytic reduction with steam/water injection	

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With New Nuclear Generation**
		Wet scrubber – lime/limestone desulfurization system (95% SO_x removal efficiency); 28,844 tons limestone/yr Fabric filters or electrostatic precipitators (95% particulate removal efficiency)		
670 permanent workers (Section 3.4)		69 workers (Section 7.2.2.2)	20 workers (Section 7.2.2.1)	
		Land Use Impacts		
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Attachment A, Table A-1, Issues 52, 53)	SMALL – Not an impact evaluated by GEIS (NRC 1996e)	SMALL to MODERATE – 96 acres required for the powerblock and associated facilities. (Section 7.2.2.2)	SMALL to MODERATE – 24 acres for facility at DAEC location; 136 acres for pipeline (Section 7.2.2.1). New gas pipeline would be built to connect with existing gas pipeline corridor.	SMALL to MODERATE – 320 to 620 acres required for the powerblock and associated facilities. (Section 7.2.2.3)

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative		
		With Coal-Fired Generation	With Gas-Fired Generation	With New Nuclear Generation
Water Quality Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Attachment A, Table A-1, Issues 5-11 and 32). Two Category 2 groundwater issues not applicable (Section 4.7, Issue 35; and Section 4.8, Issue 39). SMALL – Less than 1 percent of Cedar River is withdrawn and used onsite (Section 4.1, Issue 13; Section 4.6, Issue 34) SMALL – An average of 1,384 gpm of ground water is used (Section 4.5, Issue 33)	SMALL – Adopting by reference Category 1 issue finding (Attachment A, Attachment A, Table A-1, Issue 89).	SMALL – Construction impacts minimized by use of best management practices. Operational impacts minimized by use of the existing cooling water system that withdraws from and discharges to Cedar River. (Section 7.2.2.2)	SMALL – Reduced cooling water demands, inherent in combined-cycle design (Section 7.2.2.1)	SMALL – Construction impacts minimized by use of best management practices. Operational impacts minimized by use of the existing cooling water system that withdraws from and discharges to Cedar Rapids. (Section 7.2.2.3)
Air Quality Impacts				
SMALL – Adopting by reference Category 1 issue finding (Attachment A, Table A-1, Issue 51). Category 2 issue not applicable (Section 4.11, Issue 50).	SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issue 88)	MODERATE – 879 tons SO_x/yr 551 tons NO_x/yr 551 tons CO/yr 571 tons PM_{10}/yr 57 tons $PM_{2.5}$/yr (Section 7.2.2.2)	MODERATE – 9 tons SO_x/yr 141 tons NO_x/yr 29 tons CO/yr 61 tons $PM_{2.5}$/yr[a] (Section 7.2.2.1)	SMALL – Air emissions would be comparable to those associated with the continued operation of DAEC. (Section 7.2.2.3)

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative: With Coal-Fired Generation	No-Action Alternative: With Gas-Fired Generation	No-Action Alternative: With New Nuclear Generation
Ecological Resource Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issues 15-24, 41-48). Four Category 2 issues not applicable (Section 4.2, Issue 25; Section 4.3, Issue 26; Section 4.4, Issue 27, and Section 4.9, Issue 40).	SMALL – Adopting by reference Category 1 issue finding (Attachment A, Table A-1, Issue 90)	SMALL to MODERATE – 54 acres of forested land could be required for ash/sludge disposal over 20-year license renewal term. (Section 7.2.2.2)	SMALL to MODERATE – Construction of the pipeline could alter habitat. (Section 7.2.2.1)	SMALL to MODERATE – 320 to 620 acres required for the powerblock and associated facilities with subsequent loss of terrestrial habitat. (Section 7.2.2.3)
Threatened or Endangered Species Impacts				
SMALL – No Federally threatened or endangered species are known along the transmission corridors.	SMALL – Not an impact evaluated by GEIS (NRC 1996e)	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

		No-Action Alternative		
Proposed Action (License Renewal)	**Base (Decommissioning)**	**With Coal-Fired Generation**	**With Gas-Fired Generation**	**With New Nuclear Generation**
		Human Health Impacts		
SMALL – Adopting by reference Category 1 issues (Attachment A, Table A-1, Issues 54-56, 58, 61, and 62). SMALL – The low temperatures in the Cedar River, and the disinfection at the sewage treatment facility do not support the propagation of pathological microbes (Section 4.12, Issue 57) SMALL – Risk due to transmission-line induced currents minimal due to conformance with consensus code (Section 4.13, Issue 59)	SMALL – Adopting by reference Category 1 issue finding (Attachment A, Table A-1, Issue 86)	MODERATE – Adopting by reference GEIS conclusion that risks such as cancer and emphysema from emissions are likely (NRC 1996e)	SMALL – Adopting by reference GEIS conclusion that some risk of cancer and emphysema exists from emissions (NRC 1996e)	SMALL – Impacts would be comparable to those associated with the continued operation of DAEC. (Section 7.2.2.3)

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative		
		With Coal-Fired Generation	With Gas-Fired Generation	With New Nuclear Generation
Socioeconomic Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issues 64, 67, 91). Two Category 2 issues are not applicable (Section 4.16, Issue 66 and Section 4.17.1, Issue 68). Location in high population area with limited growth controls minimizes potential for housing impacts. Section 4.14, Issue 63). Plant property tax payment represents less than 1 percent of Linn county's total tax revenues (Section 4.17.2, Issue 69). SMALL- DAEC does not use municipal water (Section 4.15, Issue 65 and Section 4.18, Issue 70)	SMALL – Adopting by reference Category 1 issue finding (Attachment A, Table A-1, Issue 91)	SMALL to MODERATE – Reduction in permanent work force at DAEC could adversely affect surrounding counties, but would be mitigated by DAEC's proximity to Cedar Rapids (Section 7.2.2.2).	SMALL to MODERATE – Reduction in permanent work force at DAEC could adversely affect surrounding counties, but would be mitigated by DAEC's proximity to Cedar Rapids (Section 7.2.2.1)	SMALL – Impacts would be comparable to those associated with the continued operation of DAEC. (Section 7.2.2.3)
Waste Management Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issues 77-85)	SMALL – Adopting by reference Category 1 issue finding (Attachment A, Table A-1, Issue 87)	MODERATE – 66,800 tons of coal ash and 22,700 tons of scrubber sludge would require 54 acres over 20-year license renewal term. Industrial waste generated annually (Section 7.2.2.2)	SMALL – Almost no waste generation (Section 7.2.2.1)	SMALL – Impacts would be comparable to those associated with the continued operation of DAEC. (Section 7.2.2.3)

TABLE 8.0-2 (CONTINUED)
IMPACTS COMPARISON DETAIL

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternative: With Coal-Fired Generation	No-Action Alternative: With Gas-Fired Generation	No-Action Alternative: With New Nuclear Generation
Aesthetic Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issues 73, 74)	SMALL – Not an impact evaluated by GEIS (NRC 1996e)	SMALL – The coal-fired power blocks and the exhaust stacks would be visible from a moderate offsite distance (Section 7.2.2.2)	SMALL – Steam turbines and stacks would create visual impacts comparable to those from existing DAEC facilities (Section 7.2.2.1)	SMALL – Impacts would be comparable to those associated with the continued operation of DAEC. (Section 7.2.2.3)
Cultural Resource Impacts				
SMALL – SHPO consultation minimizes potential for impact (Section 4.19, Issue 71)	SMALL – Not an impact evaluated by GEIS (NRC 1996e)	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site (Section 7.2.2.2)	SMALL – 15 miles of pipeline construction could affect some cultural resources (Section 7.2.2.1)	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site (Section 7.2.2.3)

a. All particulate matter for gas-fired alternative is $PM_{2.5}$.

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. 10 CFR 51, Subpart A, Appendix B,Table B-1, Footnote 3.

Btu = British thermal unit
ft^3 = cubic foot
GEIS = Generic Environmental Impact Statement (NRC 1996e)
kWh = kilowatt hour
lb = pound
MM = million
MW = megawatt

NO_x = nitrogen oxide
$PM_{2.5}$ = particulates having diameter < 2.5 microns
PM_{10} = particulates having diameter < 10 microns
SHPO = State Historic Preservation Officer
SO_x = sulfur dioxide
yr = year

9.0 STATUS OF COMPLIANCE

9.1 PROPOSED ACTION

NRC

"The environmental report shall list all federal permits, licenses, approvals and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection…." 10 CFR 51.45(d), as adopted by 10 CFR 51.53(c)(2)

9.1.1 GENERAL

Table 9-1 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. Based on the new and significant information identification process described in Chapter 5, FPL-DA concludes that DAEC is currently in compliance with applicable environmental standards and requirements.

Table 9-2 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 9.1.2 through 9.1.5 discuss some of these items in more detail.

9.1.2 THREATENED OR ENDANGERED SPECIES

Section 7 of the Endangered Species Act (16 USC 1531 et seq.) requires federal agencies 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.

Although not required of an applicant by federal law or NRC regulation, FPL-DA has chosen to invite comment from both federal and state agencies regarding potential effects that DAEC license renewal might have on threatened and endangered species. Attachment C includes copies of FPL-DA correspondence with FWS and the Iowa Department of Natural Resources. FPL-DA did not consult with NMFS because species under the auspices of NMFS are not known to be in the DAEC vicinity.

9.1.3 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 (NRC 2004). The Act requires the applicant to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program [16 USC 1456(c)(3)(A)]. 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.

9.1.4 HISTORIC PRESERVATION

Section 106 of the National Historic Preservation Act (16 USC 470 et seq.) requires federal agencies having the authority to license any undertaking, prior to issuing the license, to take into account the effect of the undertaking on historic properties and to 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). Although not required of an applicant by federal law or NRC regulation, FPL-DA has chosen to invite comment by the Iowa SHPO. Attachment D includes copies of FPL-DA correspondence with the SHPO regarding potential effects that DAEC license renewal might have on historic or cultural resources.

9.1.5 WATER QUALITY (401) CERTIFICATION

Federal Clean Water Act Section 401 requires applicants for a federal license to conduct an activity that might result in a discharge into navigable waters 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. Appendix B contains the DAEC NPDES permit, which authorizes plant discharges. Consistent with the GEIS, DAEC is providing evidence of its NPDES permit as evidence of state water quality (401) certification. FPL-DA has received correspondence from the State of Iowa stating that there were no concerns caused by the renewal of the DAEC operating license regarding Clean Water Act requirements (Ford-Shivvers 2007).

TABLE 9.1-1
ENVIRONMENTAL AUTHORIZATIONS FOR CURRENT DAEC OPERATIONS

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011, et seq.), 10 CFR 50.10	License to operate	DPR-49	Issued: 02/21/1974 Expires: 02/21/2014	Operation of DAEC
U.S. Department of Transportation	49 USC 5108	Registration	070908 550 040QS	Issued: 07/09/2008 Expires: 06/30/2011	Hazardous materials shipments
U.S. Environmental Protection Agency	Federal Resource Conservation and Recovery Act (42 USC 6912)	Notification of Regulated Waste Activity	IAD984566133	NA	Hazardous Waste Generation/Transport
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	71-192	Issued: 08/06/1971	Cooling water system
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	3533-R3	Issued: 03/14/2004 Expires:03/13/2014	Cooling water system
Iowa Department of Natural Resources	Clean Water Act Section 401 (33 U.S.C. 1341)	Water Quality Certification	05-I-113-08-02-S	Issued: 08/26/2005	Dredging for/constructing spur dikes and subsequent maintenance dredging

TABLE 9.1-1 (CONTINUED)
ENVIRONMENTAL AUTHORIZATIONS FOR CURRENT DAEC OPERATIONS

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
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	CEMVR-OD-P-2005-1016	Issued: 09/20/2005 Expires: 12/31/2010	Dredging for spur dikes and subsequent maintenance dredging
Linn County	Linn County Flood Plain Management Regulations	Flood Plain Development Permit	PF07-015	Issued: 12/04/2007 Expires: 12/04/2008	Reinforcing river bank and adding rock
Iowa Department of Natural Resources	Code of Iowa Chapter 461A	Sovereign Lands Construction Permit	06-141	Issued: 10/10/2006 Expires:12/31/2008	Place rock along shoreline of Cedar River
Iowa Department of Natural Resources	Code of Iowa Chapter 461A	Sovereign Lands Construction Permit	07-175	Issued: 11/07/2007 Expires:12/31/2009	Repair existing rock along shoreline of Cedar River
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:50-51	Operator certification	Operator ID# 6007	Issued: 08/29/2007 Expires: 06/30/2009	Drinking water system operation certification
Iowa Department of Natural Resources	Clean Water Act (33 USC Section 1251 et seq.), Iowa Code 455B.174, IAC 567-64.3	NPDES Permit	57-00-1-04 IA0003727	Issued: 07/06/2007 Expires: 07/05/2009	Discharges to Cedar River from cooling tower, stormwater, and WWTP
Linn County	Federal Clean Air Act (42 USC 7661-7671), Iowa Code 455B:567, IAC 20-31, LCCO 10.5	Air Operation Permit	4863, 4864, 4865, 4866, 4867, 4868, 4869, 4870	Expires 11/10/2008	Air emissions from a boiler, diesel generators, and diesel USTs

TABLE 9.1-1 (CONTINUED)
ENVIRONMENTAL AUTHORIZATIONS FOR CURRENT DAEC OPERATIONS

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Iowa Department of Public Health	Iowa Homeland Security Emergency Management	Transportation Service License	NA	Issued: 06/25/2007 Expires: 06/30/2009	Transportation of radioactive waste
Iowa Department of Natural Resources	Code of Iowa Chapter 455B and part 567	Permit to operate public water system	ID# IA5715150	Issued: 11/21/2006 Expires: 12/31/2009	Non-transient non-community water supply registration for DAEC
Iowa Department of Natural Resources	Code of Iowa 455B and IAC 567:50-51	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	Water use permit
Iowa Department of Natural Resources	IAC 467-135.1(3)c	Deferral of UST regulation to NRC	NA	NA	Underground storage tanks
Tennessee Department of Environment and Conservation	Tennessee Code Annotated 68-202-206	License to ship radioactive material	T-IA-001-L08	Expires: 12/31/2008	Shipments of radioactive material to processing facility in Tennessee
Utah Department of Environmental Quality	Utah Rule 313-26	License to ship radioactive material	0210001768	Expires: 10/27/2008	Shipments of radioactive material to disposal facility in Utah

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 9.1-2
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)

9.2 ALTERNATIVES

NRC

"…The discussion of alternatives in the report shall include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements." 10 CFR 51.45(d), as required by 10 CFR 51.53(c)(2)

The coal and gas alternatives discussed in Section 7.2.2.1 can be constructed and operated to comply with all applicable environmental quality standards and requirements.

10.0 REFERENCES

Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in FPL-DA files. Some sites, for example the census data, cannot be accessed through their URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by FPL-DA have been given for these pages, even though they may not be directly accessible.

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APPENDIX A

NRC NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

FPL Energy Duane Arnold, LLC (FPL-DA) has prepared this environmental report in accordance with the requirements of U.S. Nuclear Regulatory Commission (NRC) regulation 10 CFR 51.53. NRC included in the regulation a list of National Environmental Policy Act (NEPA) issues for license renewal of nuclear power plants. Table A-1 lists these 92 issues and identifies the section in which FPL-DA addressed each applicable issue in the environmental report. For organization and clarity, FPL-DA has assigned a number to each issue and uses the issue numbers throughout the environmental report.

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a]

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Surface Water Quality, Hydrology, and Use (for all plants)			
1. Impacts of refurbishment on surface water quality	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
2. Impacts of refurbishment on surface water use	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
3. Altered current patterns at intake and discharge structures	1	4.0	4.2.1.2.1/4-5
4. Altered salinity gradients	1	NA	Issue applies to a plant feature, discharge to saltwater, which DAEC does not have.
5. Altered thermal stratification of lakes	1	NA	Issue applies to a plant feature, discharge to a lake, which DAEC does not have.
6. Temperature effects on sediment transport capacity	1	4.0	4.2.1.2.3/4-8
7. Scouring caused by discharged cooling water	1	4.0	4.2.1.2.3/4-6
8. Eutrophication	1	4.0	4.2.1.2.3/4-9
9. Discharge of chlorine or other biocides	1	4.0	4.2.1.2.4/4-10
10. Discharge of sanitary wastes and minor chemical spills	1	4.0	4.2.1.2.4/4-10
11. Discharge of other metals in waste water	1	4.0	4.2.1.2.4/4-10
12. Water use conflicts (plants with once-through cooling systems)	1	NA	Issue applies to a plant feature, once-through cooling system, which DAEC does not have.
13. Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	2	4.1	4.2.1.3/4-13
14. Refurbishment impacts to aquatic resources	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Aquatic Ecology (for all plants)			
15. Accumulation of contaminants in sediments or biota	1	4.0	4.2.1.2.4/4-10
16. Entrainment of phytoplankton and zooplankton	1	4.0	4.2.2.1.1/4-15
17. Cold shock	1	4.0	4.2.2.1.5/4-18
18. Thermal plume barrier to migrating fish	1	4.0	4.2.2.1.6/4-19
19. Distribution of aquatic organisms	1	4.0	4.2.2.1.6/4-19
20. Premature emergence of aquatic insects	1	4.0	4.2.2.1.7/4-20
21. Gas supersaturation (gas bubble disease)	1	4.0	4.2.2.1.8/4-21
22. Low dissolved oxygen in the discharge	1	4.0	4.2.2.1.9/4-23
23. Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses	1	4.0	4.2.2.1.10/4-24
24. Stimulation of nuisance organisms (e.g., shipworms)	1	4.0	4.2.2.1.11/4-25
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)			
25. Entrainment of fish and shellfish in early life stages for plants with once-through and cooling pond heat dissipation systems	2	Identified as NA in 4.2	Issue applies to a once-through and cooling pond heat dissipation system, which DAEC does not have.
26. Impingement of fish and shellfish for plants with once-through and cooling pond heat dissipation systems	2	Identified as NA in 4.3	Issue applies to a once-through and cooling pond heat dissipation system, which DAEC does not have.
27. Heat shock for plants with once-through and cooling pond heat dissipation systems	2	Identified as NA in 4.4	Issue applies to a once-through and cooling pond heat dissipation system, which DAEC does not have.
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)			
28. Entrainment of fish and shellfish in early life stages for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
29. Impingement of fish and shellfish for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33
30. Heat shock for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33
Ground-water Use and Quality			
31. Impacts of refurbishment on groundwater use and quality	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
32. Groundwater use conflicts (potable and service water; plants that use < 100 gpm)	1	NA	Issue applies to a plant operating parameter, groundwater use less than 100 gpm, which is not applicable to DAEC.
33. Groundwater use conflicts (potable, service water, and dewatering; plants that use > 100 gpm)	2	4.5	4.8.1.1
34. Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	2	4.6	4.8.1.3/4-117
35. Groundwater use conflicts (Ranney wells)	2	Identified as NA in 4.7	Issue applies to a feature, Ranney wells, which DAEC does not have.
36. Groundwater quality degradation (Ranney wells)	1	NA	Issue applies to a feature, Ranney wells, which DAEC does not have.
37. Groundwater quality degradation (saltwater intrusion)	1	NA	Issue applies to plants located in a coastal area, and DAEC is not located in such an area.
38. Groundwater quality degradation (cooling ponds in salt marshes)	1	NA	Issue applies to a feature, cooling ponds, which DAEC does not have.
39. Groundwater quality degradation (cooling ponds at inland sites)	2	Identified as NA in 4.8	Issue applies to a feature, cooling ponds, which DAEC does not have.

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Terrestrial Resources			
40. Refurbishment impacts to terrestrial resources	2	Identified as NA in 4.9	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
41. Cooling tower impacts on crops and ornamental vegetation	1	4.0	4.3.4/4-34
42. Cooling tower impacts on native plants	1	4.0	4.3.5.1./4-42
43. Bird collisions with cooling towers	1	4.0	4.3.5.2/4-45
44. Cooling pond impacts on terrestrial resources	1	NA	Issue applies to a feature, cooling ponds, which DAEC does not have.
45. Power line right-of-way management (cutting and herbicide application)	1	4.0	4.5.6.1/4-71
46. Bird collisions with power lines	1	4.0	4.5.6.2/4-74
47. Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	1	4.0	4.5.6.3/4-77
48. Floodplains and wetlands on power line right-of-way	1	4.0	4.5.7/4-81
Threatened or Endangered Species (for all plants)			
49. Threatened or endangered species	2	4.10	4.1/4-1
Air Quality			
50. Air quality during refurbishment (non-attainment and maintenance areas)	2	Identified as NA in 4.11	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
51. Air quality effects of transmission lines	1	4.0	4.5.2/4-62
Land Use			
52. Onsite land use	1	4.0	3.2/3-1
53. Power line right-of-way land use impacts	1	4.0	4.5.3/4-62

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Human Health			
54. Radiation exposures to the public during refurbishment	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
55. Occupational radiation exposures during refurbishment	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
56. Microbiological organisms (occupational health)	1	4.0	4.3.6/4-48
57. Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	2	4.12	4.3.6/4-48
58. Noise	1	4.0	4.3.7/4-49
59. Electromagnetic fields, acute effects (electric shock)	2	4.13	4.5.4.1/4-66
60. Electromagnetic fields, chronic effects	NA	Identified as NA in 4.0	NA – Not applicable. The categorization and impact finding definitions do not apply to this issue.
61. Radiation exposures to public (license renewal term)	1	4.0	4.6.2/4-87
62. Occupational radiation exposures (license renewal term)	1	4.0	4.6.3/4-95
Socioeconomics			
63. Housing impacts	2	4.14	3.7.2/3-10 (refurbishment) 4.7.1/4-101 (renewal term)
64. Public services: public safety, social services, and tourism and recreation	1	4.0	Refurbishment 3.7.4/3-14 (public services) 3.7.4.3/3-18 (safety) 3.7.4.4/3-19 (social) 3.7.4.6/3-20 (tour, rec) Renewal Term 4.7.3/4-104 (public services) 4.7.3.3/4-106 (safety) 4.7.3.4/4-107 (social) 4.7.3.6/4-107 (tour, rec)

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
65. Public services: public utilities	2	4.15	3.7.4.5/3-19 (refurbishment) 4.7.3.5/4-107 (renewal term)
66. Public services: education (refurbishment)	2	Identified as NA in 4.16	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
67. Public services: education (license renewal term)	1	4.0	4.7.3.1/4-106
68. Offsite land use (refurbishment)	2	Identified as NA in 4.17.1	3.7.5/3-20
69. Offsite land use (license renewal term)	2	4.17.2	4.7.4/4-107
70. Public services: transportation	2	4.18	3.7.4.2/3-17 (refurbishment) 4.7.3.2/4-106 (renewal term)
71. Historic and archaeological resources	2	4.19	3.7.7/3-23 (refurbishment) 4.7.7/4-114 (renewal term)
72. Aesthetic impacts (refurbishment)	1	NA	Issue applies to an activity, refurbishment, which DAEC does not plan to conduct.
73. Aesthetic impacts (license renewal term)	1	4.0	4.7.6/4-111
74. Aesthetic impacts of transmission lines (license renewal term)	1	4.0	4.5.8/4-83
Postulated Accidents			
75. Design basis accidents	1	4.0	5.3.2/5-11 (design basis) 5.5.1/5-114 (summary)
76. Severe accidents	2	4.20	5.3.3/5-12 (probabilistic analysis) 5.3.3.2/5-19 (air dose) 5.3.3.3/5-49 (water) 5.3.3.4/5-65 (groundwater) 5.3.3.5/5-96 (economic) 5.4/5-106 (mitigation) 5.5.2/5-114 (summary)
Uranium Fuel Cycle and Waste Management			
77. Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	1	4.0	6.2/6-8

TABLE A-1
DAEC ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
78. Offsite radiological impacts (collective effects)	1	4.0	Not in GEIS.
79. Offsite radiological impacts (spent fuel and high-level waste disposal)	1	4.0	Not in GEIS.
80. Nonradiological impacts of the uranium fuel cycle	1	4.0	6.2.2.6/6-20 (land use) 6.2.2.7/6-20 (water use) 6.2.2.8/6-21 (fossil fuel) 6.2.2.9/6-21 (chemical)
81. Low-level waste storage and disposal	1	4.0	6.4.2/6-36 (low-level definition) 6.4.3/6-37 (low-level volume) 6.4.4/6-48 (renewal effects)
82. Mixed waste storage and disposal	1	4.0	6.4.5/6-63
83. Onsite spent fuel	1	4.0	6.4.6/6-70
84. Nonradiological waste	1	4.0	6.5/6-86
85. Transportation	1	4.0	6.3/6-31, as revised by Addendum 1, August 1999.
Decommissioning			
86. Radiation doses (decommissioning)	1	4.0	7.3.1/7-15
87. Waste management (decommissioning)	1	4.0	7.3.2/7-19 (impacts) 7.4/7-25 (conclusions)
88. Air quality (decommissioning)	1	4.0	7.3.3/7-21 (air) 7.4/7-25 (conclusion)
89. Water quality (decommissioning)	1	4.0	7.3.4/7-21 (water) 7.4/7-25 (conclusion)
90. Ecological resources (decommissioning)	1	4.0	7.3.5/7-21 (ecological) 7.4/7-25 (conclusion)
91. Socioeconomic impacts (decommissioning)	1	4.0	7.3.7/7-24 (socioeconomic) 7.4/7-25 (conclusion)
Environmental Justice			
92. Environmental justice	NA	4.21	NA – Not applicable. The categorization and impact finding definitions do not apply to this issue.

a. Source: 10 CFR 51, Subpart A, Appendix A, Table B-1. (Issue numbers added to facilitate discussion.)
b. Source: Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437).
NEPA = National Environmental Policy Act.

APPENDIX B NPDES PERMIT

IOWA DEPARTMENT OF NATURAL RESOURCES
National Pollutant Discharge Elimination System (NPDES) Permit

OWNER NAME & ADDRESS	FACILITY NAME AND ADDRESS
INTERSTATE POWER & LIGHT COMPANY 200 1ST STREET SE CEDAR RAPIDS, IA 52406 - 0000	IP&L-DUANE ARNOLD ENERGY CENTER 3277 DAEC ROAD PALO, IA 52324 - 0000 Section 9, T 84N, R 08W LINN County

IOWA NPDES PERMIT NUMBER:	5700104	**YOU ARE REQUIRED TO FILE FOR RENEWAL OF THIS PERMIT BY:**	1/6/2009
DATE OF ISSUANCE:	7/6/2004		
DATE OF EXPIRATION:	7/5/2009	**EPA NUMBER:**	IA0003727

This permit is issued pursuant to the authority of section 402(b) of the Clean Water Act (33 U.S.C 1342(b)), Iowa Code section 455B.174, and rule 567--64.3, Iowa Administrative Code. You are authorized to operate the disposal system and to discharge the pollutants specified in this permit in accordance with the effluent limitations, monitoring requirements and other terms set forth in this permit.

You may appeal any condition of this permit by filing a written notice of appeal and request for administrative hearing with the director of this department within 30 days of your receipt of this permit.

Any existing, unexpired Iowa operation permit or Iowa NPDES permit previously issued by the department for the facility identified above is revoked by the issuance of this permit. This provision does not apply to any authorization to discharge under the terms and conditions of a general permit issued by the department or to any permit issued exclusively for the discharge of stormwater.

FOR THE DEPARTMENT OF NATURAL RESOURCES

By [signature]

Wayne Farrand, Supervisor
Wastewater Section
ENVIRONMENTAL SERVICES DIVISION

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Facility Name: P&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Outfall Number	Outfall Description
001	DISCHARGE OF COOLING TOWER BLOWDOWN FROM THE RECIRCULATING WATER SYSTEM AND STORM WATER RUNOFF.

Receiving Stream: CEDAR RIVER

Route of Flow:

Class A waters are protected for primary contact recreation in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing and water contact recreational canoeing.

Class B(WW) waters are significant resource warm waters in which temperature, flow, and other habitat characteristics are suitable for the maintenance of a wide variety of reproducing populations of warm water fish and associated aquatic communities, including sensitive species.

002 STORM WATER RUNOFF AND DISCHARGES FROM A SEQUENCING BATCH REACTOR WASTEWATER TREATMENT PLANT TREATING DOMESTIC WASTEWATER.

Receiving Stream: CEDAR RIVER

Route of Flow:

Class A waters are protected for primary contact recreation in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing and water contact recreational canoeing.

Class B(WW) waters are significant resource warm waters in which temperature, flow, and other habitat characteristics are suitable for the maintenance of a wide variety of reproducing populations of warm water fish and associated aquatic communities, including sensitive species.

Facility Name: P&L-DUANE ARNOLD ENERGY CENTER
Permit Number: 5700104

Effluent Limitations

Outfall No.: 001 . DISCHARGE OF COOLING TOWER BLOWDOWN FROM THE RECIRCULATING WATER SYSTEM AND STORM WATER RUNOFF.

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

				EFFLUENT LIMITATIONS							
				Concentration				Mass			
Wastewater Parameter	Season	Type of Limit	% Removal	7 Day Average/Min	30 Day Average	Daily Maximum	Units	7 Day Average	30 Day Average	Daily Maximum	Units
PH (MINIMUM - MAXIMUM)	YEARLY	FINAL		6.0		9.0	STD UNITS				
CHLORINE, TOTAL RESIDUAL	YEARLY	FINAL			0.2	0.5	MG/L				
CHROMIUM, TOTAL (AS CR)	YEARLY	FINAL			0.2	0.2	MG/L				
ZINC, TOTAL (AS ZN)	YEARLY	FINAL			1.0	1.0	MG/L				
DURATION OF CHLORINE DISCHARGE	YEARLY	FINAL								2.0	HOURS/DAY
ACUTE TOXICITY, CERIODAPHNIA	YEARLY	FINAL							1.0		NO TOXICITY
ACUTE TOXICITY, PIMEPHALES	YEARLY	FINAL							1.0		NO TOXICITY

Note: If seasonal limits apply, summer is from April 1 through October 31, and winter is from November 1 through March 31.

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Facility Name: P&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Effluent Limitations

Outfall No.: 002 STORM WATER RUNOFF AND DISCHARGES FROM A SEQUENCING BATCH REACTOR WASTEWATER TREATMENT PLANT TREATING DOMESTIC WASTEWATER.

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

Wastewater Parameter	Season	Type of Limit	% Removal	EFFLUENT LIMITATIONS: Concentration 7 Day Average/Min	Concentration 30 Day Average	Concentration Daily Maximum	Concentration Units	Mass 7 Day Average	Mass 30 Day Average	Mass Daily Maximum	Mass Units
CBOD5	YEARLY	FINAL		40.0	25.0		MG/L	18.0	11.0		LBS/DAY
TOTAL SUSPENDED SOLIDS	YEARLY	FINAL		45.0	30.0		MG/L	20.0	14.0		LBS/DAY
PH (MINIMUM - MAXIMUM)	YEARLY	FINAL		6.0		9.0	STD UNITS				
CHLORINE, TOTAL RESIDUAL	SUMMER	FINAL			3.4	3.4	MG/L		1.6	1.6	LBS/DAY
COLIFORM, FECAL	SUMMER	FINAL				200.0	#/100 ML				

Note: If seasonal limits apply, summer is from April 1 through October 31, and winter is from November 1 through March 31.

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Facility Name: P&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized.

(c) Chapter 63 of the Iowa Administrative Code provides you with further explanation of your monitoring requirements.

(d) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. This includes daily maximums and minimums, 30-day averages and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. Also, flow data shall be reported in million gallons per day (MGD).

(e) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the department by the fifteenth day following the close of the reporting period. Your reporting period is on a monthly basis, ending on the last day of each reporting period.

Outfall Number	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
001	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FINAL EFFLUENT
001	PH (MINIMUM - MAXIMUM)	1 TIME PER WEEK	GRAB	COOLING TOWER BLOWDOWN PRIOR TO MIXING WITH OTHER WASTESTREAMS
001	CHLORINE,TOTAL RESIDUAL	1 EVERY 2 WEEKS	GRAB	COOLING TOWER BLOWDOWN PRIOR TO MIXING WITH OTHER WASTESTREAMS
001	CHROMIUM,TOTAL (AS CR)	1 EVERY 6 MONTHS	GRAB	COOLING TOWER BLOWDOWN PRIOR TO MIXING WITH OTHER WASTESTREAMS
001	TEMPERATURE	7/WEEK OR DAILY	GRAB	FINAL EFFLUENT
001	ZINC,TOTAL (AS ZN)	1 EVERY MONTH	GRAB	COOLING TOWER BLOWDOWN PRIOR TO MIXING WITH OTHER WASTESTREAMS
001	DURATION OF CHLORINE DISCHARGE	7/WEEK OR DAILY	MEASUREMENT	MONTHLY REPORT
001	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	FINAL EFFLUENT
001	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	FINAL EFFLUENT
001	VISUAL OBSERVATION	QUARTERLY	VISUAL	FINAL EFFLUENT
002	CBOD5	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
002	TOTAL SUSPENDED SOLIDS	1 EVERY 3 MONTHS	24 HOUR COMPOSITE	RAW WASTE
002	PH (MINIMUM - MAXIMUM)	1 TIME PER WEEK	GRAB	RAW WASTE
002	TEMPERATURE	1 TIME PER WEEK	GRAB	RAW WASTE
002	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FINAL EFFLUENT

Page 5

Facility Name: P&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized.

(c) Chapter 63 of the Iowa Administrative Code provides you with further explanation of your monitoring requirements.

(d) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. This includes daily maximums and minimums, 30-day averages and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. Also, flow data shall be reported in million gallons per day (MGD).

(e) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the department by the fifteenth day following the close of the reporting period. Your reporting period is on a monthly basis, ending on the last day of each reporting period.

Outfall Number	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
002	CBOD5	1 TIME PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
002	TOTAL SUSPENDED SOLIDS	1 EVERY 3 MONTHS	24 HOUR COMPOSITE	FINAL EFFLUENT
002	PH (MINIMUM - MAXIMUM)	1 TIME PER WEEK	GRAB	FINAL EFFLUENT
002	CHLORINE,TOTAL RESIDUAL	2 TIMES PER WEEK	GRAB	SAMPLING TO OCCUR DURING PERIOD OF CHLORINE ADDITION
002	COLIFORM,FECAL	1 EVERY 3 MONTHS	GRAB	SAMPLING IS REQUIRED ONLY FROM APRIL 1 THROUGH OCTOBER 31 AT THE FINAL EFFLUENT
002	SETTLEABLE SOLIDS	2 TIMES PER WEEK	GRAB	FINAL EFFLUENT
002	TEMPERATURE	1 TIME PER WEEK	GRAB	FINAL EFFLUENT
002	VISUAL OBSERVATION	QUARTERLY	VISUAL	FINAL EFFLUENT
002	DISSOLVED OXYGEN (MINIMUM)	1 TIME PER WEEK	GRAB	DIGESTER CONTENTS
002	DISSOLVED OXYGEN (MINIMUM)	2 TIMES PER WEEK	GRAB	WEST AERATION BASIN
002	SOLIDS,MIXED LIQUOR SUSPENDED	1 TIME PER WEEK	GRAB	WEST AERATION BASIN
002	TEMPERATURE	2 TIMES PER WEEK	GRAB	WEST AERATION BASIN
002	30-MINUTE SETTLEABILITY	2 TIMES PER WEEK	GRAB	WEST AERATION BASIN
002	DISSOLVED OXYGEN (MINIMUM)	2 TIMES PER WEEK	GRAB	EAST AERATION BASIN
002	SOLIDS,MIXED LIQUOR SUSPENDED	1 TIME PER WEEK	GRAB	EAST AERATION BASIN

Facility Name: P&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized.

(c) Chapter 63 of the Iowa Administrative Code provides you with further explanation of your monitoring requirements.

(d) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. This includes daily maximums and minimums, 30-day averages and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. Also, flow data shall be reported in million gallons per day (MGD).

(e) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the department by the fifteenth day following the close of the reporting period. Your reporting period is on a monthly basis, ending on the last day of each reporting period.

Outfall Number	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
002	TEMPERATURE	2 TIMES PER WEEK	GRAB	EAST AERATION BASIN
002	30-MINUTE SETTLEABILITY	2 TIMES PER WEEK	GRAB	EAST AERATION BASIN

Facility Name: IP&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

Outfall Number: 001

Ceriodaphnia and Pimephales Toxicity Effluent Testing

1. For facilities that have not been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within three (3) months of permit issuance. For facilities that have been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within twelve months (12) of the last toxicity test.

2. The test organisms that are to be used for acute toxicity testing shall be Ceriodaphnia dubia and Pimephales promelas. The acute toxicity testing procedures used to demonstrate compliance with permit limits shall be those listed in 40 CFR Part 136 and adopted by reference in rule 567--63.1(1). The method for measuring acute toxicity is specified in USEPA. October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., EPA 821-R-02-012.

3. The diluted effluent sample must contain a minimum of 4.40 % effluent and no more than 95.60 % of culture water.

4. One valid positive toxicity result will require quarterly testing for effluent toxicity.

5. Two successive valid positive toxicity results or three positive results out of five successive valid effluent toxicity tests will require a toxic reduction evaluation to be completed to eliminate the toxicity.

6. A non-toxic test result shall be indicated as a "1" on the monthly operation report. A toxic test result shall be indicated as a "2" on the monthly operation report. DNR Form 542-1381 shall also be submitted to the DNR field office along with the monthly operation report.

Ceriodaphnia and Pimephales Toxicity Effluent Limits

The 30 day average mass limit of "1" for the parameters Acute Toxicity, Ceriodaphnia and Acute Toxicity, Pimephales means no positive toxicity results.

Definition: "Positive toxicity result" means a statistical difference of mortality rate between the control and the diluted effluent sample. For more information see USEPA. October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 821-R-01-012.

Facility Name: IP&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

PROHIBITIONS

1. There shall be no discharge of polychlorinated biphenyl compounds such as those used for transformer fluid.

2. There shall be no discharge of the 126 priority pollutants listed in Appendix "A" of 40 CFR Part 423 discharged in cooling tower blowdown as a result of the use of cooling tower maintenance chemicals, except that chromium and zinc may be discharged subject to the effluent limitations and monitoring requirements specified on pages #3 and #5 of this permit.

3. Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time.

4. There shall be no chemicals added to the circulating water system during off-line conditions.

Facility Name: IP&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

ADDITIONAL MONITORING AND REPORTING REQUIREMENTS

Compliance with the prohibition on discharging priority pollutants in cooling tower blowdown (page 9, #2) may be demonstrated either by sampling and analysis of the cooling tower blowdown or by certification that the discharge complies with this requirement as follows:

a. If compliance is to be demonstrated by sampling and analysis, the permittee shall analyze a sample of cooling tower blowdown at least once every six (6) months for each of the 126 priority pollutants listed in Appendix "A" of 40 CFR Part 423. These samples shall consist of cooling tower blowdown collected at a point prior to its mixing with any other water or wastewater and at a time that is representative of normal facility operations. Results of this monitoring shall be submitted with the monthly operation report.

b. As an alternative to the monitoring specified in part "a", the permittee may submit an evaluation that demonstrates that there is no detectable amount of any of the 126 priority pollutants, except chromium and zinc, in cooling tower blowdown resulting from chemicals used for cooling tower maintenance. If the evaluation is approved by the department, the permittee may certify compliance by submitting the following statement at least once each six (6) months with the monthly operation report:

"I certify to the best of my knowledge and belief that no detectable concentrations of the 126 priority pollutants listed in Appendix "A" of 40 CFR Part 423, except as specifically authorized by the NPDES permit, were discharged in cooling tower blowdown as a result of the use of cooling tower maintenance chemicals since filing the last report."

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Facility Name: IP&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

SPECIAL CONDITIONS APPLICABLE TO THE ZEBRA MUSSEL CONTROL PROGRAM

1. You must comply at all times with the effluent limitations, monitoring and reporting requirements and all other requirements specified in this NPDES permit and any amendments thereto.
2. Each molluscicide treatment is limited to 24 hours.
3. The maximum number of molluscicide treatments each year is 4. Each treatment must be separated by at least 45 days. Treatments should be planned to occur immediately before and after the zebra mussel spawning period and at 1-2 times throughout the remainder of the year.
4. The concentration of quaternary ammonium compounds in the effluent shall not exceed 50 μg/L as measured at the end of the discharge pipe whenever a nonoxidizing molluscicide is used.
5. Detoxification with bentonite clay or another absorptive medium is required whenever a nonoxidizing molluscicide is used unless you can demonstrate that the active ingredient concentration in any single outfall will not exceed the level specified in #4 above.
6. At least one acute toxicity test on the final discharge must be conducted annually and at the time that the molluscicide is being used. Test conditions must conform to those specified on page #8 of the permit.
7. As new information is received and reviewed, and the results of the approved treatments evaluated, previously unanticipated environmental impacts might be detected. This permit may be amended, or revoked and reissued, if unanticipated environmental or human health impacts occur or are reported from other locations in scientific literature. You are encouraged to continually evaluate alternative methods of zebra mussel control and to investigate innovative, non-chemical methods of preventing zebra mussels from interfering with facility operations.
8. The concentration of free available chlorine in the discharge shall not exceed 0.50 mg/L at any time as specified on page #3 of the permit.

Facility Name: IP&L-DUANE ARNOLD ENERGY CENTER

Permit Number: 5700104

SEWAGE SLUDGE HANDLING AND DISPOSAL REQUIREMENTS

"Sewage sludge" is solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge does not include the grit and screenings generated during preliminary treatment.

1. The permittee shall comply with all existing Federal and State laws and regulations that apply to the use and disposal of sewage sludge, not including sludge from the ash pond, and with technical standards developed pursuant to Section 405(d) of the Clean Water Act when such standards are promulgated. If an applicable numerical limit or management practice for pollutants in sewage sludge is promulgated after issuance of this permit that is more stringent than a sludge pollutant limit or management practice specified in existing Federal or State laws or regulations, this permit shall be modified, or revoked and reissued, to conform to the regulations promulgated under Section 405(d) of the Clean Water Act. The permittee shall comply with the limitation no later than the compliance deadline specified in the applicable regulations.

2. The permittee shall provide written notice to the Department of Natural Resources prior to any planned changes in sludge disposal practices.

3. Land application of sewage sludge shall be conducted in accordance with criteria established rule IAC 567--67.1 through 67.11(455B).

STORM WATER DISCHARGES COVERED UNDER THIS PERMIT

PART I. DESCRIPTION OF STORM WATER DISCHARGES

A. DISCHARGES COVERED UNDER THIS PERMIT

This permit authorizes the discharge of storm water associated with industrial activity from outfalls 001 and 002 identified on page #2 of this permit.

B. STORM WATER DISCHARGE NOT ASSOCIATED WITH INDUSTRIAL ACTIVITY

Storm water discharge associated with industrial activity (as defined in chapter 567-60 of the Iowa Administrative Code) authorized by this permit may be combined with other sources of storm water that are not classified as associated with industrial activity pursuant to 40 CFR 122.26(b)(14) or with wastewater from outfalls defined elsewhere in this permit.

C. LIMITATION ON COVERAGE

Unless specifically identified elsewhere in this permit, the following discharges are not authorized by this permit:

- non-storm water discharges except those listed elsewhere in this permit,
- the discharge of substances resulting from an on-site spill;
- storm water discharge associated with industrial activity from construction activity, specifically any land disturbing activity of one or more acres;
- washwaters from material handling and processing areas,
- washwaters from drum, tank, or container rinsing and cleaning, and
- vehicle and equipment washwaters.

D. NON-STORM WATER DISCHARGES

The following non-storm water discharges may be authorized by this permit provided the non-storm water component of the discharge is in compliance with the conditions listed in the storm water portion of this permit:

discharges from fire fighting activities, fire hydrant flushing, potable water sources including waterline flushing, drinking fountain water, uncontaminated compressor condensate, irrigation drainage, lawn watering, routine external building washdown that does not use detergents or other compounds, pavement washwaters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used, air conditioning condensate, uncontaminated springs, uncontaminated ground water, and foundation or footing drains where flows are not contaminated with process materials such as solvents.

PART II. SPECIAL CONDITIONS

ADDITIONAL REQUIREMENTS FOR FACILITIES WITH SALT STORAGE

Storage piles of salt used for deicing or other commercial or industrial purposes and that generate a storm water discharge to waters of the United States shall be enclosed or covered to prevent exposure to precipitation, except for exposure resulting from adding or removing materials from the pile.

PART III. STORM WATER POLLUTION PREVENTION PLAN

The storm water pollution prevention plan as described and required in the permit previously issued to this facility must continue to be implemented. The plan must identify potential sources of pollution that may reasonably be expected to affect the quality of storm water discharge associated with industrial activity from the facility. In addition, the plan must describe and ensure the implementation of practices that are used to reduce the pollutants in storm water discharge associated with industrial activity at the facility and to ensure compliance with the terms and conditions of this permit. The permittee must continue to implement the provisions of the storm water pollution prevention plan required under the previous permit.

The plan shall be amended whenever there is a change in design, construction, operation, or maintenance, that has a significant effect on the potential for the discharge of pollutants to the waters of the United States or if the storm water pollution prevention plan proves to be ineffective in eliminating or significantly minimizing the discharge of pollutants or in otherwise achieving the general objectives of controlling pollutants in storm water discharges associated with industrial activity. New owners shall review the existing plan and make appropriate changes.

The storm water pollution prevention plan required by this permit must be modified within 14 calendar days of the occurrence of any "hazardous condition" to provide a description of the release, the circumstances leading to the release, and the date of the release. In addition, the plan must be reviewed by the permittee to identify measures to prevent the reoccurrence of such a condition and to respond to such discharges, and the plan must be modified where appropriate.

PART IV. DEFINITIONS

1. Storm water means storm water runoff, snow melt runoff, and surface runoff and drainage.
2. Waters of the United States means all waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide;

a. All interstate waters, including interstate wetlands;

b. All other waters such as interstate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

c. That are or could be used by interstate or foreign travelers for recreational or other purposes;

d. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

e. That are used or could be used for industrial purposes by industries in interstate commerce;

f. All impoundment of waters otherwise defined as waters of the United States under this definition;

g. Tributaries of waters identified in paragraphs (a) through (d) of this definition;

h. The territorial sea; and

i. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition,

QUARTERLY VISUAL EXAMINATION OF STORM WATER QUALITY.

You shall perform and document a quarterly, visual examination of storm water discharge associated with industrial activity from outfalls 001 and 002. The examination must be made at least once in each of the following periods: January through March; April through June; July through September; and October through December during daylight hours unless there is insufficient rainfall or snow melt to produce a runoff event. Each examination shall be made a minimum of 30 days from the last examination at the same outfall.

Examinations shall be made within the first 30 minutes (or as soon thereafter as practical, but not to exceed 1 hour) of when the runoff or snowmelt begins discharging. The examinations shall document observations of color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution. The examination must be conducted in a well-lit area. No analytical tests are required to be performed. All examinations shall be made of the discharge resulting from a storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Where practicable, the same individual should carry out the examination of discharges for the entire permit term.

Visual examination reports must be maintained on-site in the pollution prevention plan. Do not submit the results of the visual observations to the Department unless they have been requested. The report shall include the examination date and time, examination personnel, the nature of the discharge (i.e., runoff or snow melt), visual quality of the storm water discharge (including observations of color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of storm water pollution), and probable sources of any observed storm water contamination.

If you have two or more outfalls that, based on a consideration of industrial activity, significant materials, and management practices and activities within the area drained by the outfall, the permittee reasonably believes discharge substantially identical effluents, you may conduct an examination of effluent from one of such outfalls and report that the observations also apply to the substantially identical outfall(s). You must then include in the storm water pollution prevention plan a description of the location of the outfalls and explain in detail why the outfalls are expected to discharge substantially identical effluents. In addition, for each outfall that you believe is representative, an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area [e.g., low (under 40 percent), medium (40 to 65 percent), or high (above 65 percent)] shall be provided in the plan.

STANDARD CONDITIONS

1. DEFINITIONS

(a) 7 day average means the sum of the total daily discharges by mass, volume or concentration during a 7 consecutive day period, divided by the total number of days during the period that measurements were made. Four 7 consecutive day periods shall be used each month to calculate the 7-day average. The first 7-day period shall begin with the first day of the month.

(b) 30 day average means the sum of the total daily discharges by mass, volume or concentration during a calendar month, divided by the total number of days during the month that measurements were made.

(c) daily maximum means the total discharge by mass, volume or concentration during a twenty-four hour period.

2. DUTY TO COMPLY

You must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. Issuance of this permit does not relieve you of the responsibility to comply with all local, state and federal laws, ordinances, regulations or other legal requirements applying to the operation of your facility.
[See 40 CFR 122.41(a) and 567-64.3(11) IAC]

3. DUTY TO REAPPLY

If you wish to continue to discharge after the expiration date of this permit you must file an application for reissuance at least 180 days prior to the expiration date of this permit.
[See 567-64.8(1) IAC]

4. NEED TO HALT OR REDUCE ACTIVITY

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.
[See 567-64.7(5)(j) IAC]

5. DUTY TO MITIGATE

You shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.
[See 567-64.7(5)(i) IAC]

6. PROPERTY RIGHTS

This permit does not convey any property rights of any sort or any exclusive privileges.

7. TRANSFER OF TITLE

If title to your facility, or any part of it, is transferred the new owner shall be subject to this permit.
[See 567-64.14 IAC]

You are required to notify the new owner of the requirements of this permit in writing prior to any transfer of title. The Director shall be notified in writing within 30 days of the transfer.

8. PROPER OPERATION AND MAINTENANCE

All facilities and control systems shall be operated as efficiently as possible and maintained in good working order. A sufficient number of staff, adequately trained and knowledgeable in the operation of your facility shall be retained at all times and adequate laboratory controls and appropriate quality assurance procedures shall be provided to maintain compliance with the conditions of this permit.
[See 40 CFR 122.41(e) and 567 64.7(5)(f) IAC]

9. DUTY TO PROVIDE INFORMATION

You must furnish to the Director, within a reasonable time, any information the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. You must also furnish to the Director, upon request, copies of any records required to be kept by this permit.

10. MAINTENANCE OF RECORDS

You are required to maintain records of your operation in accordance with 567-63.2 IAC.

11. PERMIT MODIFICATION, SUSPENSION OR REVOCATION

(a) This permit may be modified, suspended, or revoked and reissued for cause including but not limited to those specified in 567-64.3(11) IAC.

(b) This permit may be modified due to conditions or information on which this permit is based, including any new standard the department may adopt that would change the required effluent limits.
[See 567-64.3(11) IAC]

(c) If a toxic pollutant is present in your discharge and more stringent standards for toxic pollutants are established under Section 307(a) of the Clean Water Act, this permit will be modified in accordance with the new standards.
[See 567-64.7(5)(g) IAC]

The filing of a request for a permit modification, revocation or suspension, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

12. SEVERABILITY

The provisions of this permit are severable and if any provision or application of any provision to any circumstance is found to be invalid by this department or a court of law, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected by such finding.

STANDARD CONDITIONS

13. INSPECTION OF PREMISES, RECORDS, EQUIPMENT, METHODS AND DISCHARGES
You are required to permit authorized personnel to:

(a) Enter upon the premises where a regulated facility or activity is located or conducted or where records are kept under conditions of this permit.

(b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit.

(c) Inspect, at reasonable times, any facilities, equipment, practices or operations regulated or required under this permit.

(d) Sample or monitor, at reasonable times, for the purpose of assuring compliance or as otherwise authorized by the Clean Water Act.

14. TWENTY-FOUR HOUR REPORTING
You shall report any noncompliance that may endanger human health or the environment. Information shall be provided orally within 24 hours from the time you become aware of the circumstances. A written submission that includes a description of noncompliance and its cause; the period of noncompliance including exact dates and times, whether the noncompliance has been corrected or the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent a reoccurrence of the noncompliance must be provided within 5 days of the occurrence. The following instances of noncompliance must be reported within 24 hours of occurrence:

(a) Any unanticipated bypass which exceeds any effluent limitation in the permit.
[See 40 CFR 122.44(g)]

(b) Any upset which exceeds any effluent limitation in the permit.
[See 40 CFR 122.44(n)]

(c) Any violation of a maximum daily discharge limit for any of the pollutants listed by the Director in the permit to be reported within 24 hours.
[See 40 CFR 122.44(g)]

15. OTHER NONCOMPLIANCE
You shall report all instances of noncompliance not reported under Condition #14 at the time monitoring reports are submitted.

16. ADMINISTRATIVE RULES
Rules of this Department which govern the operation of your facility in connection with this permit are published in Part 567 of the Iowa Administrative Code (IAC) in Chapters 60-64 and 120-122. Reference to the term "rule" in this permit means the designated provision of Part 567 of the Iowa Administrative Code.

17. NOTICE OF CHANGED CONDITIONS
You are required to report any changes in existing conditions or information on which this permit is based:

(a) Facility expansions, production increases or process modifications which may result in new or increased discharges of pollutants must be reported to the Director in advance. If such discharges will exceed effluent limitations, your report must include an application for a new permit.
[See 567-64.7(5)(a) IAC]

(b) If any modification of, addition to, or construction of a disposal system is to be made, you must first obtain a written permit from this Department.
[See 567-64.2 IAC]

(c) If your facility is a publicly owned treatment works or otherwise may accept waste for treatment from industrial contributors see 567-64.3(5) IAC for further notice requirements.

(d) You shall notify the Director as soon as you know or have reason to believe that any activity has occurred or will occur which would result in the discharge of any toxic pollutant which is not limited in this permit.
[See 40 CFR 122.42(a)]

You must also notify the Director if you have begun or will begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the permit application.

18. OTHER INFORMATION
Where you become aware that you failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report, you must promptly submit such facts or information.

STANDARD CONDITIONS

19. UPSET PROVISION

(a) Definition - "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense in an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph *"c"* of this condition are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for demonstration of an upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed, contemporaneous operating logs, or other relevant evidence that;

(1) An upset occurred and that the permittee can identify the cause(s) of the upset.
(2) The permitted facility was at the time being properly operated; and
(3) The permittee submitted notice of the upset to the Department in accordance with 40 CFR 122.41(l)(6)(ii)(B).
(4) The permittee complied with any remedial measures required by Item #5 of the Standard Conditions of this permit.

(d) Burden of Proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

20. FAILURE TO SUBMIT FEES

This permit may be revoked, in whole or in part, if the appropriate permit fees are not submitted within thirty (30) days of the date of notification that such fees are due.

21. BYPASSES

(a) Definition - Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

(b) Prohibition of bypass, Bypass is prohibited and the department may take enforcement action against a permittee for bypass unless:

(1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance;

(3) The permittee submitted notices as required by paragraph *"d"* of this section.

(c) The Director may approve an anticipated bypass after considering its adverse effects if the Director determines that it will meet the three conditions listed above.

(d) Reporting bypasses. Bypasses shall be reported in accordance with 567-63.6 IAC.

22. SIGNATORY REQUIREMENTS

Applications, reports or other information submitted to the Department in connection with this permit must be signed and certified as required by 567-64.3(8) IAC.

23. USE OF CERTIFIED LABORATORIES

Effective October 1, 1996, analyses of wastewater, groundwater or sewage sludge that are required to be submitted to the department as a result of this permit must be performed by a laboratory certified by the State of Iowa. Routine, on-site monitoring for pH, temperature, dissolved oxygen, total residual chlorine and other pollutants that must be analyzed immediately upon sample collection, settleable solids, physical measurements, and operational monitoring tests specified in 567-63.3(4) are excluded from this requirement.

National Pollutant Discharge Elimination System

Notice Date : 05/21/2004

The Iowa Department of Natural Resources is proposing to approve an application for reissuance of an NPDES (National Pollutant Discharge Elimination System) permit for the discharges described below:

DISCHARGER NAME AND ADDRESS:

IP&L-DUANE ARNOLD ENERGY CENTER
3277 DAEC ROAD
PALO, IA 52324 - 0000

LOCATION: **Township** 84N **Range** 08W **Section** 9 **County:** LINN

RECEIVING STREAM: CEDAR RIVER

Class A waters are protected for primary contact recreation in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing and water contact recreational canoeing.

Class B(WW) waters are significant resource warm waters in which temperature, flow, and other habitat characteristics are suitable for the maintenance of a wide variety of reproducing populations of warm water fish and associated aquatic communities, including sensitive species.

DESCRIPTION OF DISCHARGES

001 DISCHARGE OF COOLING TOWER BLOWDOWN FROM THE RECIRCULATING WATER SYSTEM AND STORM WATER RUNOFF.

002 STORM WATER RUNOFF AND DISCHARGES FROM A SEQUENCING BATCH REACTOR WASTEWATER TREATMENT PLANT TREATING DOMESTIC WASTEWATER.

Anyone wishing to comment on or object to the proposed issuance of this permit must do so in writing within forty-five (45) days of the date shown at the top of this notice. All comments received will be considered in the final determination. If no objections are received within forty-five (45) days, the Department will issue a final permit. You may request the Department hold a public hearing by submitting a written request stating specific reasons why a hearing should be held.

Comments, objections, and requests for hearings must be addressed to the: IOWA DEPARTMENT OF NATURAL RESOURCES, Environmental Services Division, Wastewater Section, 502 East 9th Street, Des Moines, IA 50319.

Copies of this notice, the proposed permit and other information are on file and available for public inspection from 8:00 AM to 4:30 PM Monday through Friday at the above address. Copies of this information may be requested by calling John Warren at 515-242-6148 or E-mail at john.warren@dnr.state.ia.us

APPENDIX C SPECIAL-STATUS SPECIES CORRESPONDENCE

Table of Contents

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

April 13, 2007
NG-07-0236

Robyn Thorson, Regional Director
Region 3, U.S. Fish and Wildlife Service
1 Federal Drive
BHW Federal Building
Fort Snelling, MN 55111

Subject: FPL Energy Duane Arnold LLC *
License Renewal Project
NRC Informal Consultation Preparation

Dear Ms Thorson:

FPL Energy Duane Arnold, LLC is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. We intend the application to be consistent with your agencies' interests and the priorities of our community. Although Duane Arnold's current operating license does not expire until February 2014, the NRC's rigorous license renewal process and other regulatory reviews make it prudent for us to submit this application for license renewal to the NRC in late 2008.

As a part of the license renewal process, the Nuclear Regulatory Commission (NRC) requires that applicants identify adverse impacts to rare and endangered species resulting from continued operation of the facility or refurbishment activities associated with the license renewal. This assessment, which will be contained in the Environmental Report submitted as part of the application, will address specific environmental issues related to the continued operation of the Station during the license renewal period. Following our submission of the application, the NRC will request an informal consultation with your office with respect to the matters referenced in this letter.

It is our intent that, by contacting you at this point in the process, we can identify any deficiencies, concerns, or data needed so that those areas identified can be addressed to assure that the consultation process proceeds smoothly and efficiently.

It is FPL Energy Duane Arnold's conclusion that operation of the Station does not have an adverse impact on any rare or endangered species. In addition, there are neither operational refurbishments nor major replacement activities planned as a result of this license renewal action that will invalidate that conclusion.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusion. To assist you in responding to this request, I have enclosed a site description and figures depicting the site and the associated transmission lines.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
Palo, IA 52324
Herb_Giorgio@fpl.com
(319) 851.7264

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold

Enclosures:
Duane Arnold Site Description
Duane Arnold Site Figure
Duane Arnold 6 Mile Vicinity Map
Duane Arnold Transmission System

* FPL Energy Duane Arnold LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

Duane Arnold 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 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 m. A paved county highway provides access to the site.

TOPOGRAPHY

A relatively flat plain at approximate elevation 750 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.

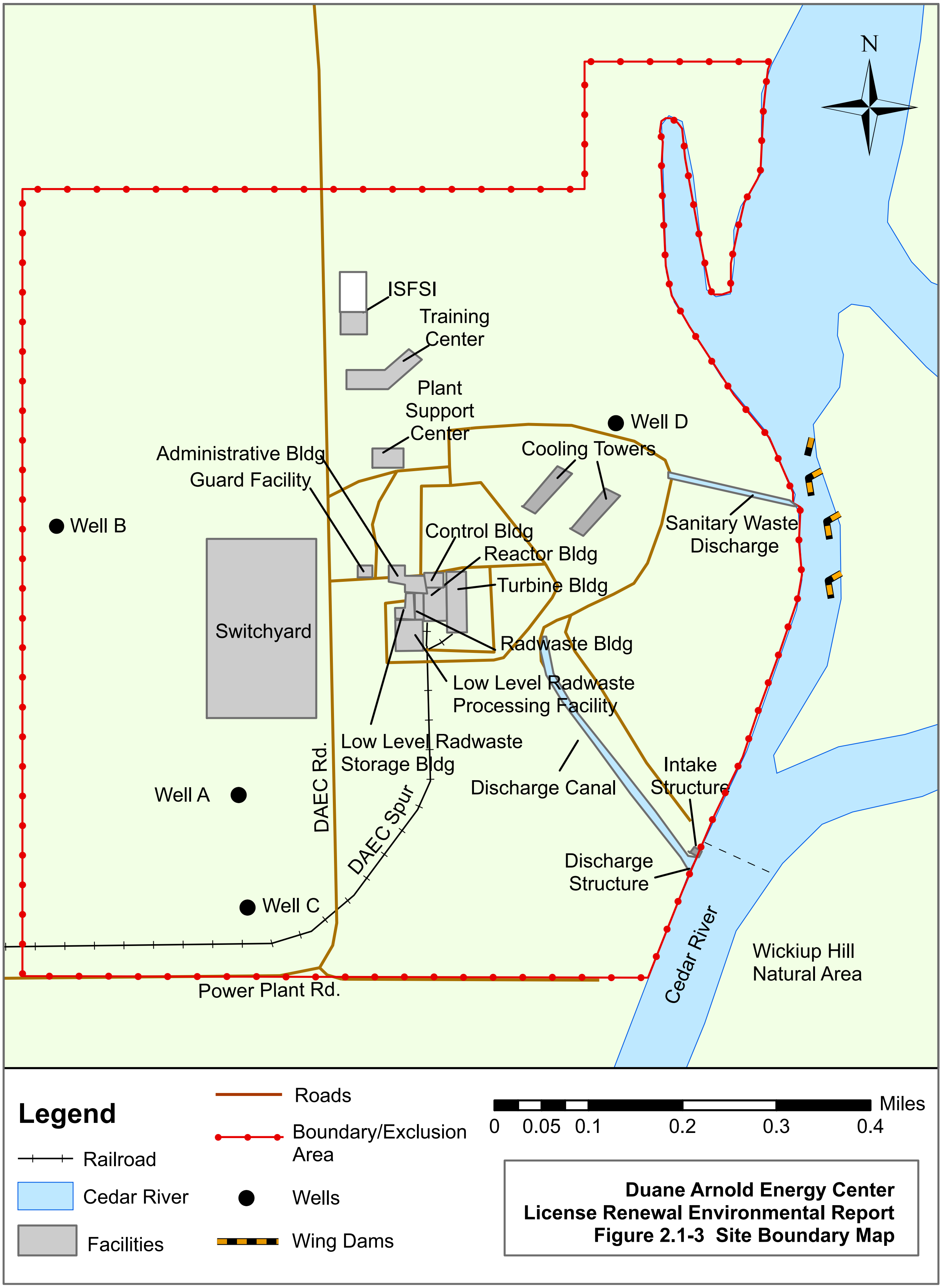
To the northwest, the land rises to an elevation of 850 ft.

Adjacent to the east is another heavily wooded low area that constitutes the current flood plain. This area is very flat and extends approximately 1500 ft to the west bank of the river.

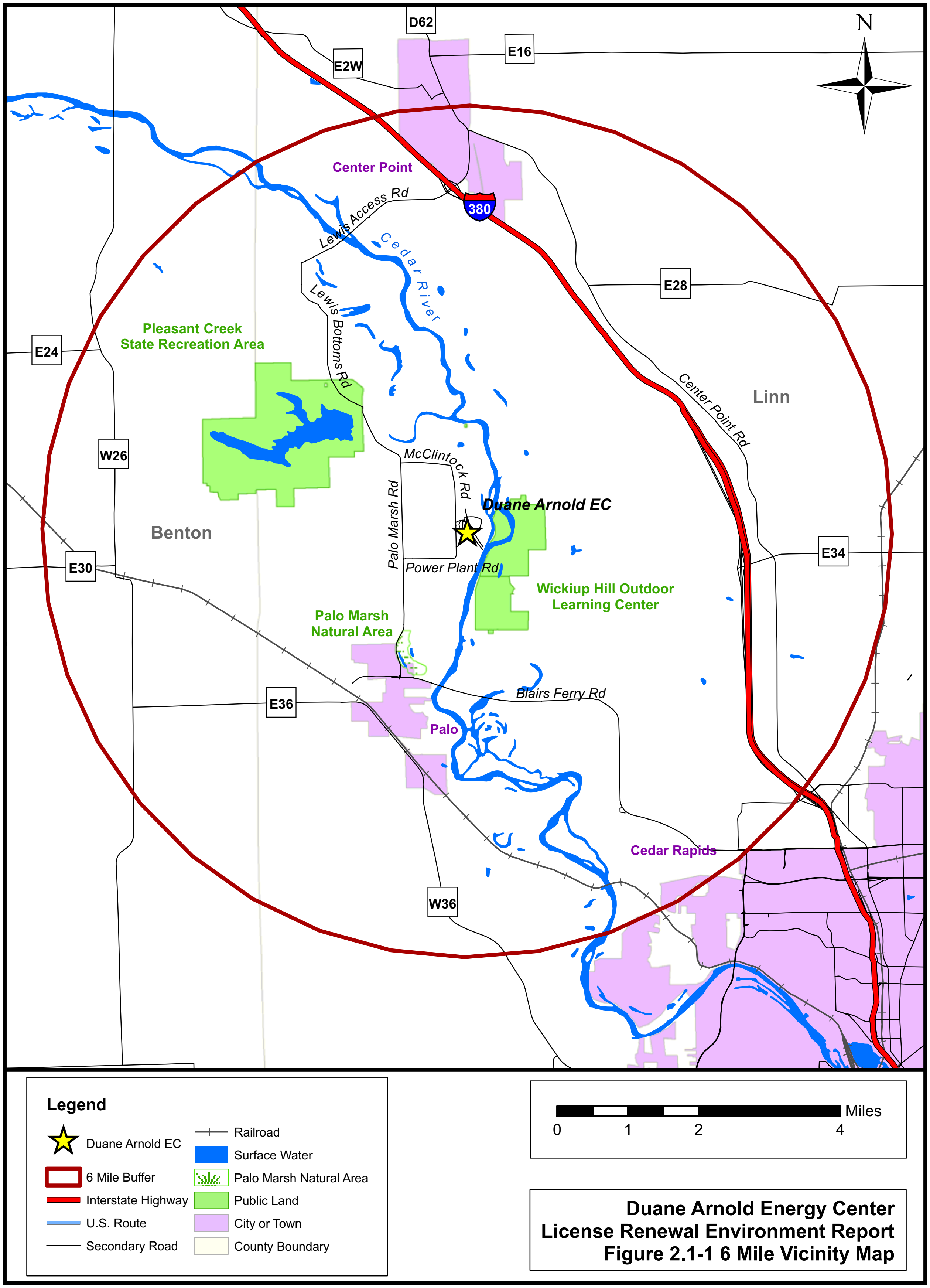
The general topographical features in this portion of the Cedar River consist of broad valleys with relatively narrow flood plains. In many places, these broad valleys merge almost imperceptibly into the adjacent uplands. Away from the immediate vicinity of the river, the land is gently rolling farmland.

TRANSMISSION LINE CORRIDORS

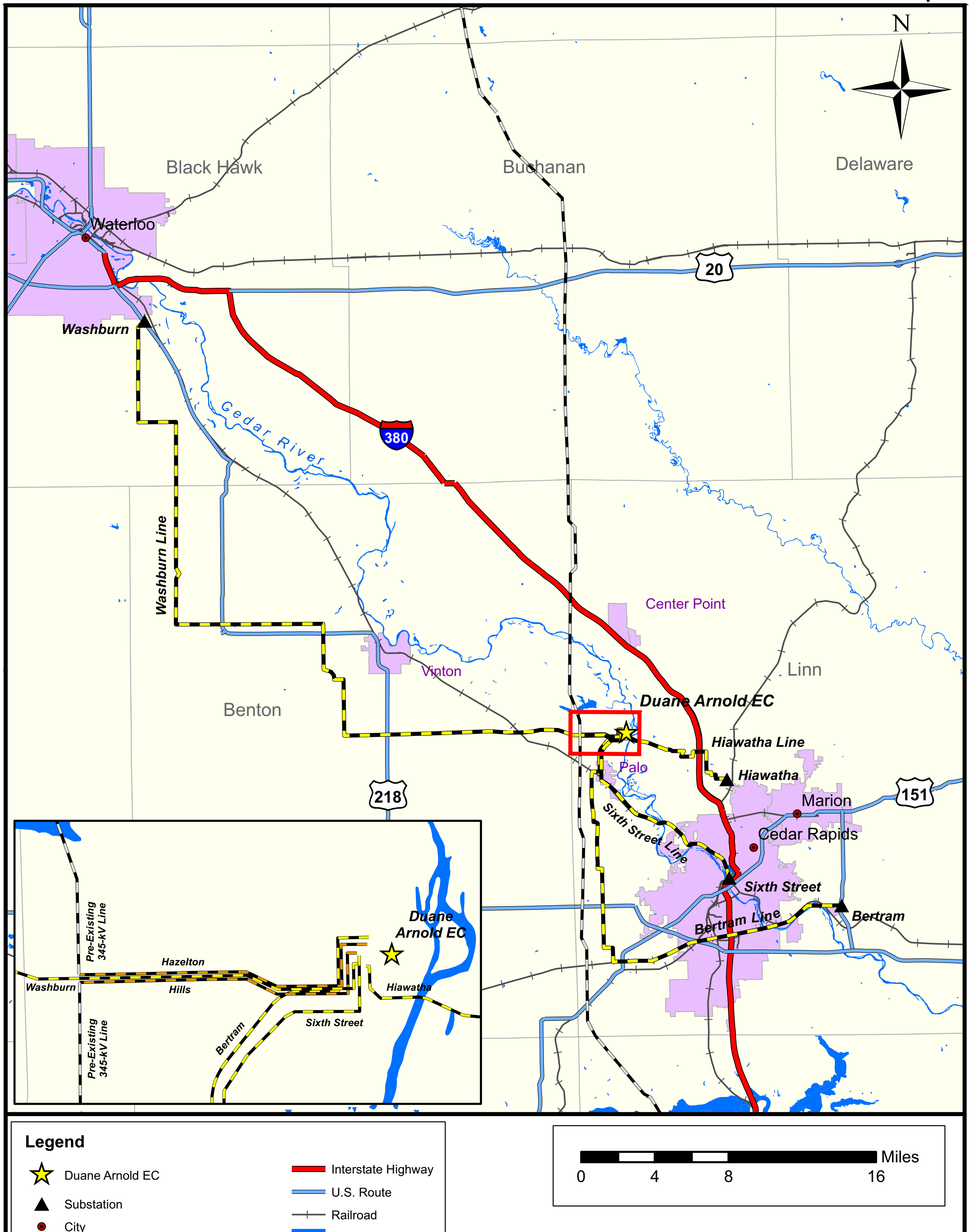
Five transmission-line systems extend westward in a 665-ft corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near this road, two 161-kV lines depart and continue within a corridor of 100-ft basic width (generally narrower along railroad and public rights-of-way) in a southerly direction. At the village of Palo, one of these lines follows a railroad right of way southeasterly 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 in a 500-ft 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.



Duane Arnold Energy Center
License Renewal Environmental Report
Figure 2.1-3 Site Boundary Map



Duane Arnold Energy Center
License Renewal Environment Report
Figure 2.1-1 6 Mile Vicinity Map



Duane Arnold Energy Center
License Renewal Environment Report
Figure 3.1-1 Transmission System

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

RECEIVED
JUL 11 2007

July 3, 2007

Mr. Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

Dear Mr. Middlesworth:

We have reviewed your April 13, 2007, request for information concerning any impacts to federally listed threatened or endangered species as a result of a proposed license renewal project at the FPL Energy Duane Arnold facility for an additional twenty years. The project site is located near Cedar Rapids, 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 Fish and Wildlife 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 furnishing you the following list of species which may be present in the concerned area:

Classification	Common Name	Scientific Name	Habitat
Threatened	Bald eagle	*Haliaeetus leucocephalus*	Wintering, Breeding
Threatened	Prairie bush clover	*Lespedeza leptostachya*	Dry to mesic prairies with gravelly soil
Threatened	Western prairie fringed orchid	*Platanthera praeclara*	Mesic to wet prairies

The threatened bald eagle (*Haliaeetus leucocephalus*) is listed as breeding in Linn County, Iowa. It is also listed as wintering along large rivers, lakes, and reservoirs in Linn County. During the winter, this species feeds on fish in the open water areas created by dam tailwaters, the warm water effluents of power plants and municipal and industrial discharges, or in power plant cooling ponds. The more severe the winter, the greater the ice coverage and the more concentrated the eagles become. They roost at night in groups in large trees adjacent to the river in areas that are protected from the harsh winter elements. They perch in large shoreline trees to rest or feed on fish. There is no critical habitat

Mr. Gary Van Middlesworth 2

designated for this species. The eagle may not be harassed, harmed, or disturbed when present nor may nest trees be cleared.

The prairie bush clover (*Lespedeza leptostachya*) is listed as threatened and is considered to potentially occur statewide in Iowa based on historical habitat. It occupies dry to mesic prairies with gravelly soil. There is no critical habitat designated for this species. Federal regulations prohibit any commercial activity involving this species or the destruction, malicious damage or removal of this species from Federal land or any other lands in knowing violation of State law or regulation, including State criminal trespass law. This species should be searched for whenever prairie remnants are encountered.

The western prairie fringed orchid (*Platanthera praeclara*) is listed as threatened and is considered to potentially occur statewide in Iowa based on historical records and habitat distribution. It occupies wet grassland habitats. There is no critical habitat designated for this species. Federal regulations prohibit any commercial activity involving this species or the destruction, malicious damage or removal of this species from Federal land or any other lands in knowing violation of State law or regulation, including State criminal trespass law. This species should be searched for whenever wet prairie remnants are encountered.

The Corps of Engineers is the Federal agency responsible for wetland regulation, and we recommend that you contact them for assistance in delineating the wetland types and acreage within the project boundary. Priority consideration should be given to avoid impacts to wetland areas. Any future activities in the study area that would alter wetlands may require a Section 404 permit. Unavoidable impacts will require a mitigation plan to compensate for any losses of wetland functions and values. The U.S. Army Corps of Engineers, Clock Tower Building, P.O. Box 2004, Rock Island, Illinois 61201, should be contacted for information about the permit process.

These comments provide technical assistance only and do not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act, do not fulfill the requirements under Section 7 of the Endangered Species Act, nor do they represent the review comments of the U.S. Department of the Interior on any forthcoming environmental statement.

Thank you for the opportunity to provide comments early in the planning process. If you have any additional questions or concerns, please contact Heidi Woeber of my staff.

Sincerely,

Richard C. Nelson
Field Supervisor

S:\Office Users\Heidi\linncoFPLENERGY.doc

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy

Duane Arnold Energy Center

April 13, 2007
NG-07-0233

Richard Leopold, Director
Iowa Department of Natural Resources
502 E. 9th Street
Des Moines, IA 50319-0034

Subject: FPL Energy Duane Arnold LLC*
License Renewal Project
NRC Informal Consultation Preparation for Threatened & Endangered Species and Water Usage

Dear Mr. Leopold:

FPL Energy Duane Arnold, LLC is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. We intend the application to be consistent with your agencies' interests and the priorities of our community. Although Duane Arnold's current operating license does not expire until February 2014, the NRC's rigorous license renewal process and other regulatory reviews make it prudent for us to submit this application for license renewal to the NRC in late 2008.

As a part of the license renewal process, the Nuclear Regulatory Commission (NRC) requires that applicants identify impacts to rare and endangered species resulting from continued operation of the facility or refurbishment activities associated with the license renewal. In addition, NRC will review water usage and compliance with applicable portions of the Clean Water Act (CWA). This assessment, which will be contained in the Environmental Report submitted as part of the application, will address specific environmental issues related to the continued operation of the Station during the license renewal period. Following our submission of the application, the NRC may request an informal consultation with your office with respect to the matters referenced in this letter. The NRC may also ask you to confirm the exempt status of FPL Energy Duane Arnold from the applicability of 316(b).

It is our intent that, by contacting you at this point in the process, we can identify any deficiencies, concerns, or data needed so that those areas identified can be addressed to assure that the consultation process proceeds smoothly and efficiently.

It is FPL Energy Duane Arnold's conclusion that operation of the Station does not have an adverse impact on any rare or endangered species. In addition, there are neither operational, refurbishments nor major replacement activities planned as a result of this license renewal action that will invalidate that conclusion.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusion. To assist you in responding to this request, I have enclosed a site description and figures depicting the site and the associated transmission lines.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
Palo IA 52324
Herb_Giorgio@fpl.com
(319) 851.7264.

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosures:
Duane Arnold Site Description
Duane Arnold Site Figure
Duane Arnold 6 Mile Vicinity Map
Duane Arnold Transmission System

* FPL Energy Duane Arnold LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

Duane Arnold 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 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 m. A paved county highway provides access to the site.

TOPOGRAPHY
A relatively flat plain at approximate elevation 750 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.

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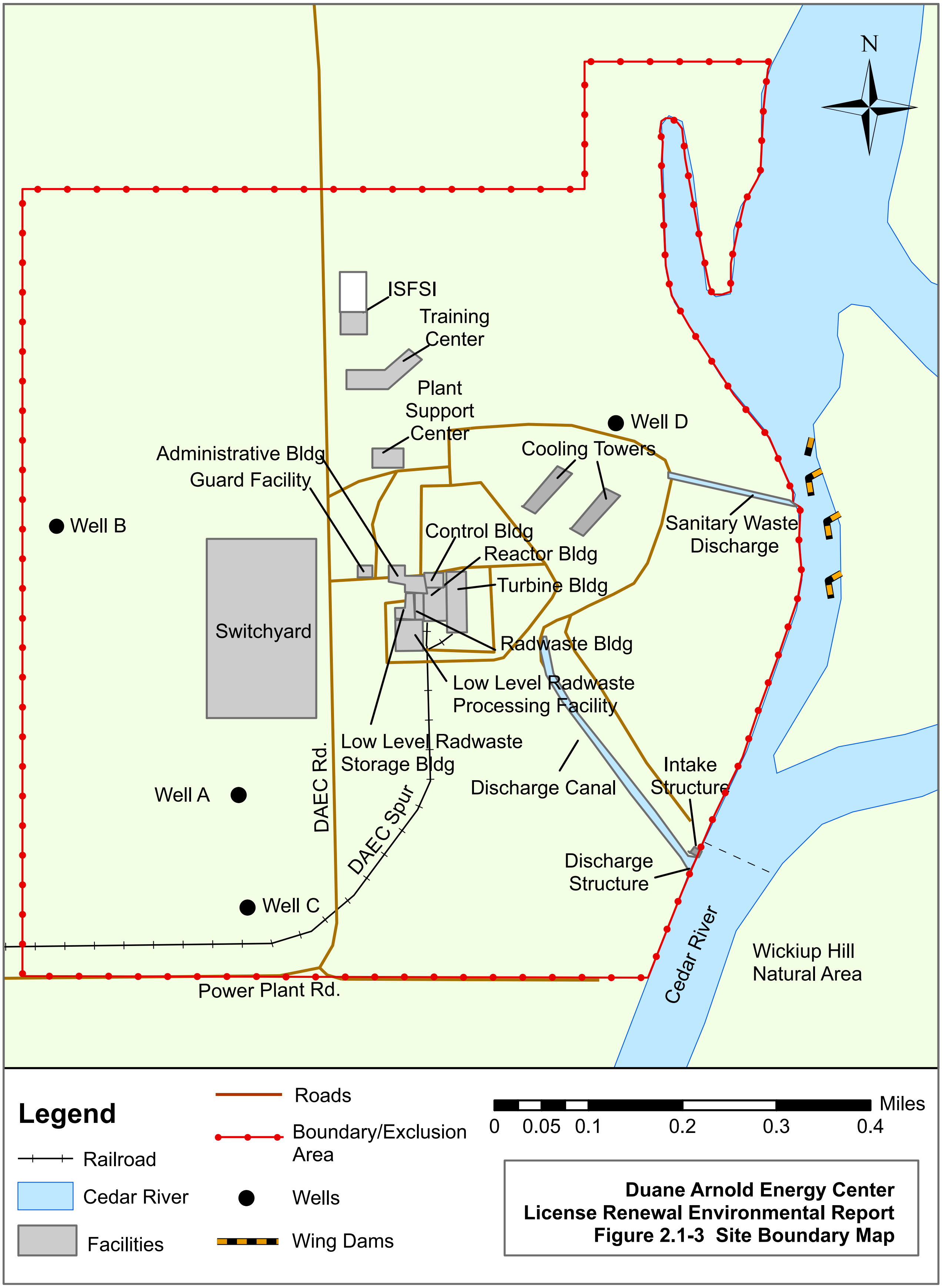
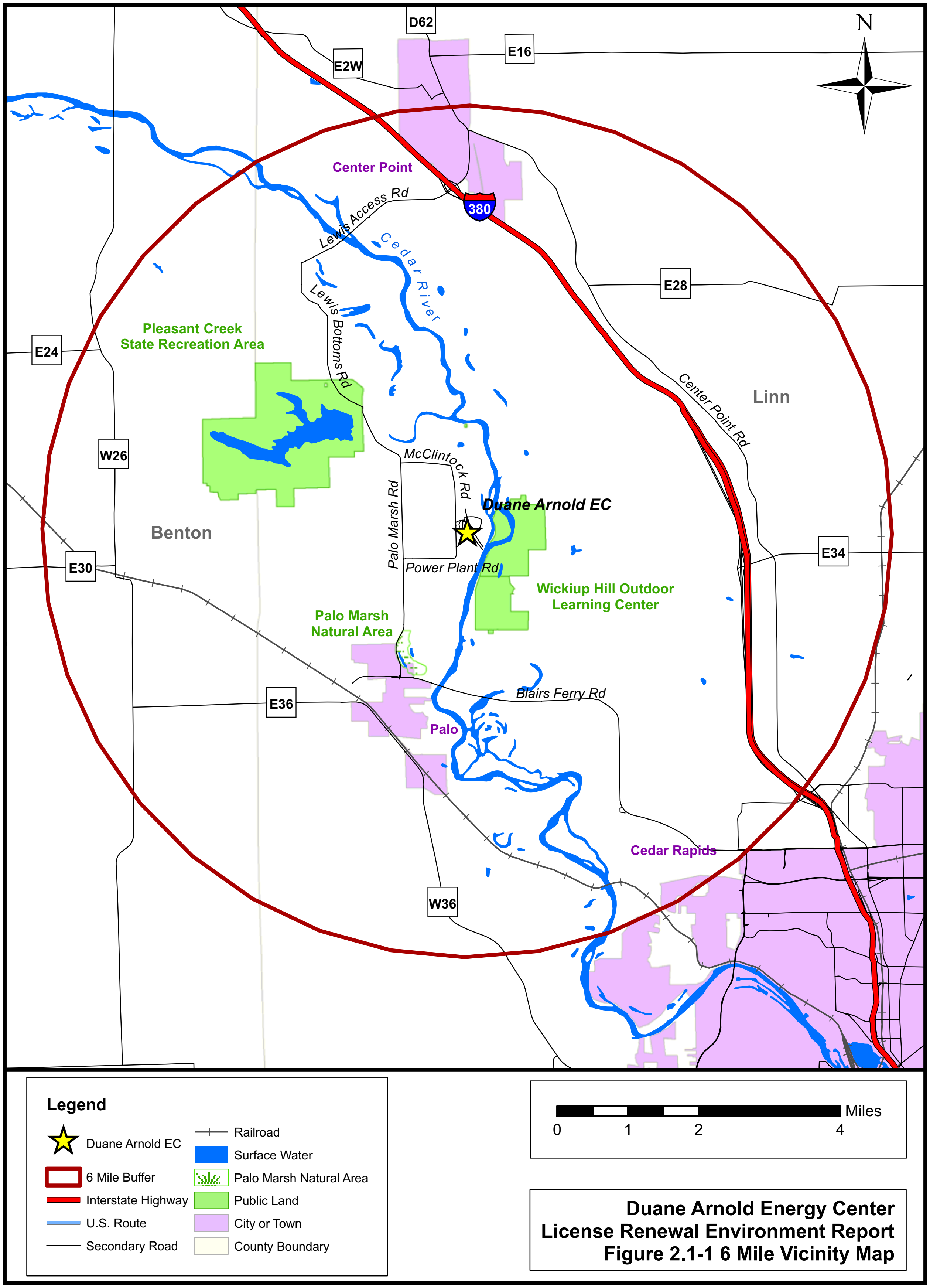


Duane Arnold Energy Center
License Renewal Environmental Report
Figure 2.1-3 Site Boundary Map



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License Renewal Environment Report
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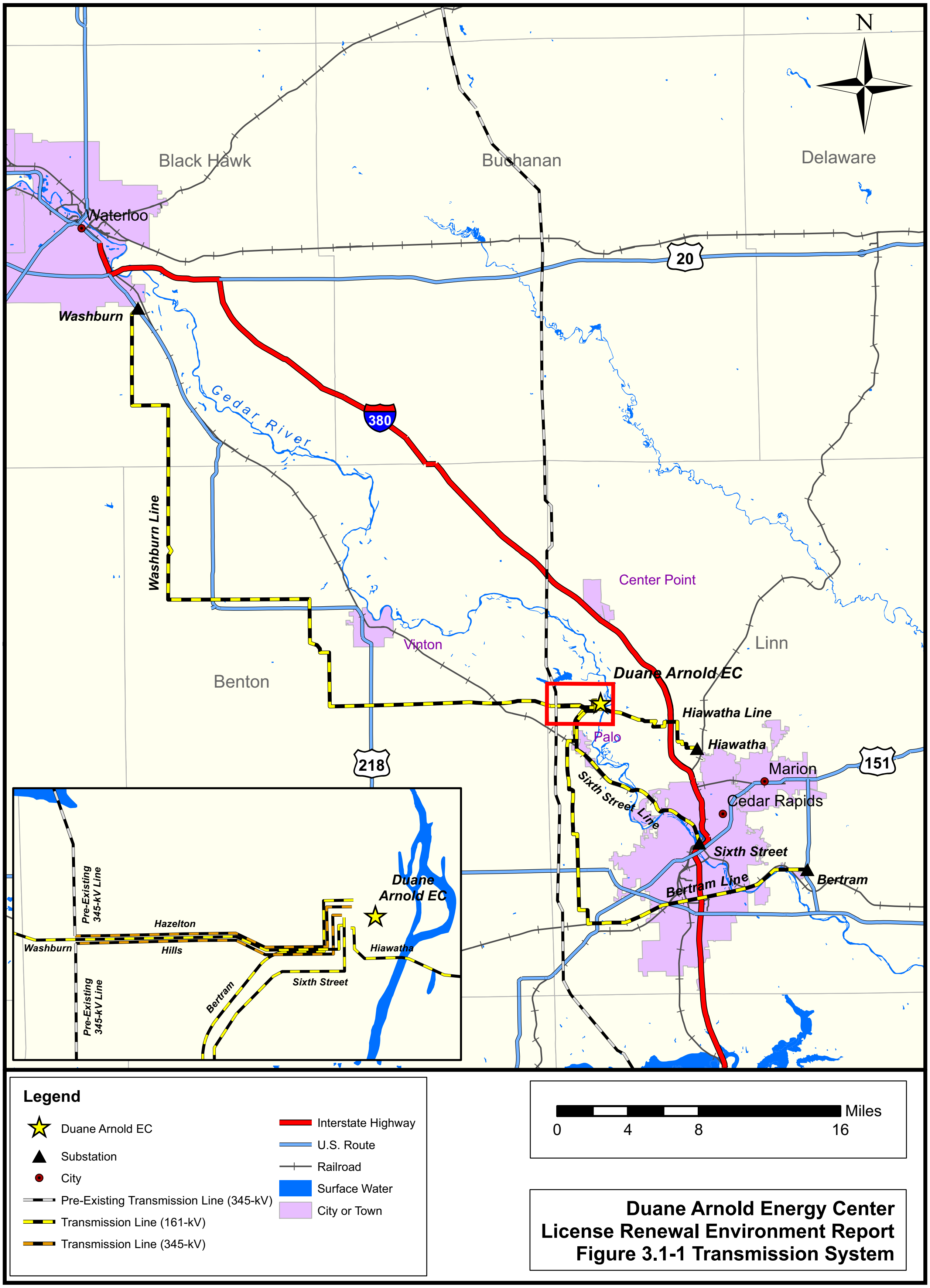

Duane Arnold Energy Center
License Renewal Environment Report
Figure 3.1-1 Transmission System

Fields of Opportunities

STATE OF IOWA

CHESTER J. CULVER, GOVERNOR
PATTY JUDGE, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
RICHARD A. LEOPOLD, DIRECTOR

November 7, 2007

Gary Van Middlesworth
FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, IA 52324

RE: Environmental Review for Natural Resources
License renewal project
NRC informal consultation preparation for Threatened and Endangered Species and Water Usage
Palo, Linn County, IA
S9, 10/T84N/R8W

Dear Van Middlesworth:

Thank you for inviting our comments on the impact of the above referenced 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. In addition, we have searched our records of the project area and found no site-specific records of rare species or significant natural communities that would be impacted by this project. However, our 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 any potential comment from the Environmental Services Division of this Department. This letter does not constitute a permit and before proceeding with this project, permits may be needed from this Department or from other state or federal agencies.

Any construction activity that bares the soil of an area greater than or equal to 1 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.

TDD 515-242-5967 www.iowadnr.gov

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 addressed to Jim McGraw at (515) 242-5167.

If you have any questions about this letter or require further information, please contact me at (515) 281-6341.

Sincerely,

Diane Ford-Shivvers
Deputy Division Administrator
Conservation and Recreation Division

FILE COPY: Inga Foster
Tracking Number: 1803

APPENDIX D CULTURAL RESOURCES CORRESPONDENCE

Table of Contents

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

April 13, 2007
NG-07-0234

Stephen C. Lensink
Interim State Archaeologist
Office of the State Archaeologist
700 South Clinton Street Building
University of Iowa
Iowa City, IA 52242-1030

Subject: FPL Energy Duane Arnold, LLC *
License Renewal Project
NRC Informal Consultation Preparation for Cultural Resources

Dear Mr. Lensink:

FPL Energy Duane Arnold, LLC is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. We intend the application to be consistent with your agency's interests and the priorities of our community. Although Duane Arnold's current operating license does not expire until February 2014, the NRC's rigorous license renewal process and other regulatory reviews make it prudent for us to submit this application for license renewal to the NRC in late 2008.

As part of the license renewal process, the NRC requires license applicants to assess the impact of the proposed action on cultural resources. This assessment, which will be contained in the Environmental Report submitted as part of the application, will address specific environmental issues related to the continued operation of the Station during the license renewal period. Following our submission of the application, the NRC may request an informal consultation with your office with respect to the matters referenced in this letter.

It is our intent that, by contacting you at this point in the process, we can identify any deficiencies, concerns, or data needed so that those areas identified can be addressed to assure that the consultation process proceeds smoothly and efficiently.

Neither operational, refurbishment nor major replacement activities are planned as a result of this license renewal action that will impact previously undisturbed land. Therefore, FPL Energy Duane Arnold believes there will be no cultural resource impacts from license renewal activities.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusion. To assist you in responding to this request, I have enclosed a site description and a pertinent figure of the area.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
Palo IA 52324
Herb_Giorgio@fpl.com
(319) 851.7264.

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosures:
Duane Arnold Site Description
Duane Arnold Site Boundary Map
Duane Arnold 6 Mile Vicinity Map
Duane Arnold Transmission System

* FPL Energy Duane Arnold LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy
Duane Arnold Energy Center

April 13, 2007
NG-07-0235

Gordon Hendrickson
Division Administrator
State Historic Society of Iowa
600 E. Locust Street
Des Moines, IA 50319

Subject: FPL Energy Duane Arnold, LLC *
License Renewal Project
NRC Informal Consultation Preparation for Cultural Resources

Dear Mr. Hendrickson:

FPL Energy Duane Arnold, LLC is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. We intend the application to be consistent with your agency's interests and the priorities of our community. Although Duane Arnold's current operating license does not expire until February 2014, the NRC's rigorous license renewal process and other regulatory reviews make it prudent for us to submit this application for license renewal to the NRC in late 2008.

As part of the license renewal process, the NRC requires license applicants to assess the impact of the proposed action on cultural resources. This assessment, which will be contained in the Environmental Report submitted as part of the application, will address specific environmental issues related to the continued operation of the Station during the license renewal period. Following our submission of the application, the NRC may request an informal consultation with your office with respect to the matters referenced in this letter.

It is our intent that, by contacting you at this point in the process, we can identify any deficiencies, concerns, or data needed so that those areas identified can be addressed to assure that the consultation process proceeds smoothly and efficiently.

Neither operational, refurbishment nor major replacement activities are planned as a result of this license renewal action that will impact previously undisturbed land. Therefore, FPL Energy Duane Arnold believes there will be no cultural resource impacts from license renewal activities.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusion. To assist you in responding to this request, I have enclosed a site description and pertinent figures of the area.

If you have any comments, concerns or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
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Herb_Giorgio@fpl.com
(319) 851.7264.

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

Oct 2, 2007
DAEC-07-0847

June Strand
Review and Compliance Program
Iowa State Historic Preservation Office
Capital Complex
600 E. Locust St
Des Moines, IA 50319-0290

Subject: FPL Energy Duane Arnold LLC
License Renewal Project
NRC Informal Consultation Preparation for Cultural Resources

Dear Ms. Strand:

In April 2007 we informed your office that FPL Energy Duane Arnold, LLC was preparing an application to the US Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. Our intent was to assure that your office knew of the undertaking and to make ourselves available for discussions if so desired.

Since that time, we have completed the preliminary draft and are enclosing a copy for your review. In it we have concluded that operation of the Station does not have an adverse impact on cultural resources. In addition, there are neither operational, refurbishments nor major replacement activities planned as a result of this license renewal action that will invalidate that conclusion.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusions. For us to stay on schedule, we request receipt of your response by November 15, 2007.

Following our submission of the application, the NRC may request an informal consultation with your office with respect to the matters referenced in this letter.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
Palo IA 52324
Herb_Giorgio@fpl.com
(319) 851.7264

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold

Enc: Applicants Environmental Report - Operating License Renewal Stage Preliminary draft August 2007

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy

Duane Arnold Energy Center

May 1, 2007
NG-07-399

Ms. Cathy Noe Got , Acting Natural Resource Director
Sac and Fox Tribal Offices
349 Meskwaki Rd
Tama, IA 52339

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Ms. Noe Got ,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

As part of the license renewal process, we are contacting nearby Native American Tribal officials who may have an interest in the cultural resources at the site. To assist you, we have enclosed a site description and two appropriate site figures.

Because neither major replacement activities nor actions are planned during the license renewal term that will impact previously undisturbed land, FPL Energy Duane Arnold believes there will be no cultural resource impacts from license renewal activities. The Duane Arnold facility has a procedure in place to control and monitor excavation activities on previously undisturbed site property should excavation become necessary.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact

Herb Giorgio
Environmental Lead, License Renewal
Duane Arnold Energy Center
3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosure:
Duane Arnold Site Description
Duane Arnold Site Boundary Map
Duane Arnold Six Mile Vicinity Map

*FPL Energy Duane Arnold LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

FPL Energy

Duane Arnold Energy Center

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

May 1, 2007
NG-07-400

Jonathan Buffalo, Historic Preservation Director
Sac and Fox Tribal Offices
349 Meskwaki Rd
Tama, IA 52339

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Buffalo,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

As part of the license renewal process, we are contacting nearby Native American Tribal officials who may have an interest in the cultural resources at the site. To assist you, we have enclosed a site description and two appropriate site figures.

Because neither major replacement activities nor actions are planned during the license renewal term that will impact previously undisturbed land, FPL Energy Duane Arnold believes there will be no cultural resource impacts from license renewal activities. The Duane Arnold facility has a procedure in place to control and monitor excavation activities on previously undisturbed site property should excavation become necessary.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact

Herb Giorgio
Environmental Lead, License Renewal
Duane Arnold Energy Center
3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosure:
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Duane Arnold Site Boundary Map
Duane Arnold Six Mile Vicinity Map

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FPL Energy
Duane Arnold Energy Center

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

May 1, 2007
NG-07-393

Ms. DeAnne Bahr, Historic Preservation
Kansas and Nebraska Sac and Fox Tribal Offices
305 North Maine
Reserve, KS 66434

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Ms. Bahr,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

As part of the license renewal process, we are contacting nearby Native American Tribal officials who may have an interest in the cultural resources at the site. To assist you, we have enclosed a site description and two appropriate site figures.

Because neither major replacement activities nor actions are planned during the license renewal term that will impact previously undisturbed land, FPL Energy Duane Arnold believes there will be no cultural resource impacts from license renewal activities. The Duane Arnold facility has a procedure in place to control and monitor excavation activities on previously undisturbed site property should excavation become necessary.

If you have any comments or questions, or seek any specific data to further explain the license renewal process, please contact

Herb Giorgio
Environmental Lead, License Renewal
Duane Arnold Energy Center
3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosure:
Duane Arnold Site Description
Duane Arnold Site Boundary Map
Duane Arnold Six Mile Vicinity Map

* FPL Energy Duane Arnold, LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

Sac and Fox Nation of Missouri
in Kansas and Nebraska

305 North Main Street • Reserve, Kansas 66434
Phone (785) 742-7471 • Fax (785) 742-3785

August 6, 2007

Herb Giorgio
Environmental Lead, License Renewal
Duane Arnold Energy Center
3277 DAEC Rd
Palo IA 52324

Dear Mr. Giorgio:

Thank you for your letter, which is in compliance with Section 106 of the National Historic Preservation Act, and Section 110.

Project: FPL Energy Duane Arnold License Renewal

The Sac and Fox Nation of Missouri in Kansas and Nebraska NAGPRA department have determined the above project as:

No objections. However, if human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction, please stop immediately and notify NAGPRA representative, Johnathan L. Buffalo, at the address below.

There are two other bands of Sac and Fox that also need to be contacted, the Sac and Fox Nation of Oklahoma and the Sac and Fox of the Mississippi in Iowa.

Johnathan Buffalo, NAGPRA Representative
Sac and Fox of the Mississippi in Iowa
349 Meskwaki Rd.
Tama, IA 52339-9629

Sandra Massey, NAGPRA Representative
Sac and Fox Nation of Oklahoma
Rt. 2, Box 246
Stroud, OK 74079

If you have any questions, please contact me at the number or address above.

Sincerely,

Deanne Bahr
Sac and Fox Nation of Missouri in Kansas and Nebraska
NAGPRA Contact Representative

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

May 1, 2007
NG-07-398

Ms. Sandra Massie, NAGPRA Coordinator
Oklahoma and Nebraska Sac and Fox Tribal Offices
RR2 Box 246
Stoud, OK 74079

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Ms. Massie,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

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Vice President
FPL Energy Duane Arnold, LLC

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FPL Energy

Duane Arnold Energy Center

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

May 1, 2007
NG-07-394

Mr. Pat Murphy, Cultural Coordinator
Iowa Tribe of Kansas and Nebraska
206 S. Buckeye
Abilene, KS 67410

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Murphy,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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Herb Giorgio
Environmental Lead, License Renewal
Duane Arnold Energy Center
3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

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Duane Arnold Site Boundary Map
Duane Arnold Six Mile Vicinity Map

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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy

Duane Arnold Energy Center

May 1, 2007
NG-07-396

Ms. Joyce Miller, Cultural Preservation Specialist
Iowa Tribe of Oklahoma
RR 1, Box 721
Perkins, OK 74059

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Ms. Miller,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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Sincerely yours,

Gary Van Middlesworth
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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

May 1, 2007
NG-07-395

Mr. Sam Allen, Cultural Preservation Officer
Nebraska Flandreau Santee Sioux Tribal Office
PO Box 283
Flandreau, SD 57028

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Allen,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

As part of the license renewal process, we are contacting nearby Native American Tribal officials who may have an interest in the cultural resources at the site. To assist you, we have enclosed a site description and two appropriate site figures.

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Duane Arnold Energy Center
3277 DAEC Rd
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Sincerely yours,

Gary Van Middlesworth
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FPL Energy Duane Arnold, LLC

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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

May 1, 2007
NG-07-401

Mr. Roger Trudell, Tribal Chairman
South Dakota Santee Sioux Tribal Office
108 Spirit Lake Avenue W
Niobrara, SD 68760-7219

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Trudell,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

May 1, 2007
NG-07-397

Mr. Richard Goulden, Director of Tribal Energy Development
Otoe-Missouria Tribal Offices
8151 Highway 177
Red Rock, OK 74651

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Goulden,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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3277 DAEC Rd
Palo, IA 52324
(319) 851.7164

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

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FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPL Energy.

Duane Arnold Energy Center

May 1, 2007
NG-07-392

Mr. Larry Garvin, Director Heritage Preservation
Wisconsin Ho-Chunk Cultural Preservation Tribal Office
W9814 Airport Road
Black River Falls, WI 54615

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project – Cultural Resources

Dear Mr. Garvin,

This letter is being sent to you to inform you that FPL Energy Duane Arnold, LLC located in Palo, Iowa is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years.

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Enclosure: Duane Arnold Site Description

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 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 m. A paved county highway provides access to the site.

TOPOGRAPHY

A relatively flat plain at approximate elevation 750 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.

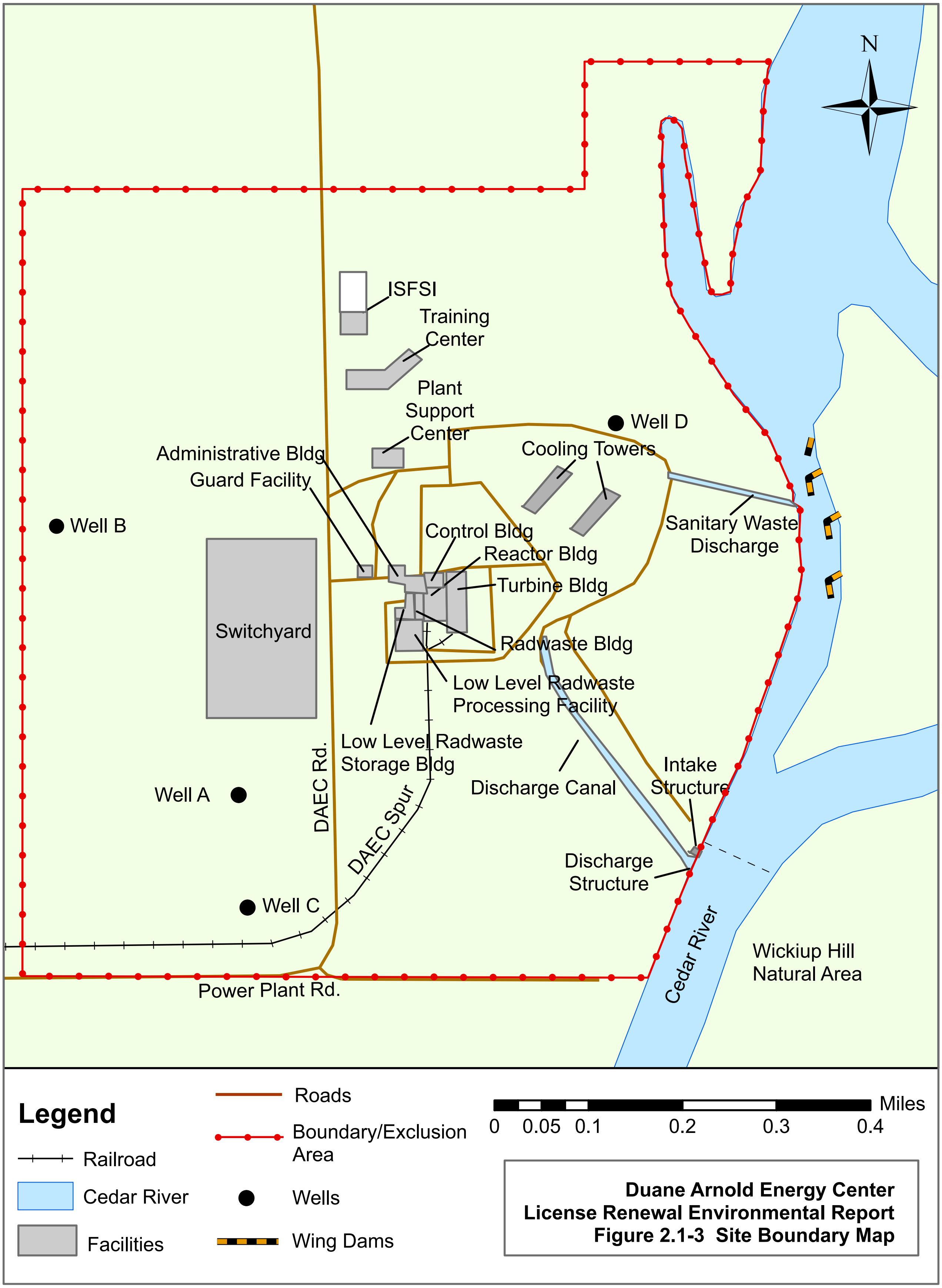
To the northwest, the land rises to an elevation of 850 ft.

Adjacent to the east is another heavily wooded low area that constitutes the current flood plain. This area is very flat and extends approximately 1500 ft to the west bank of the river.

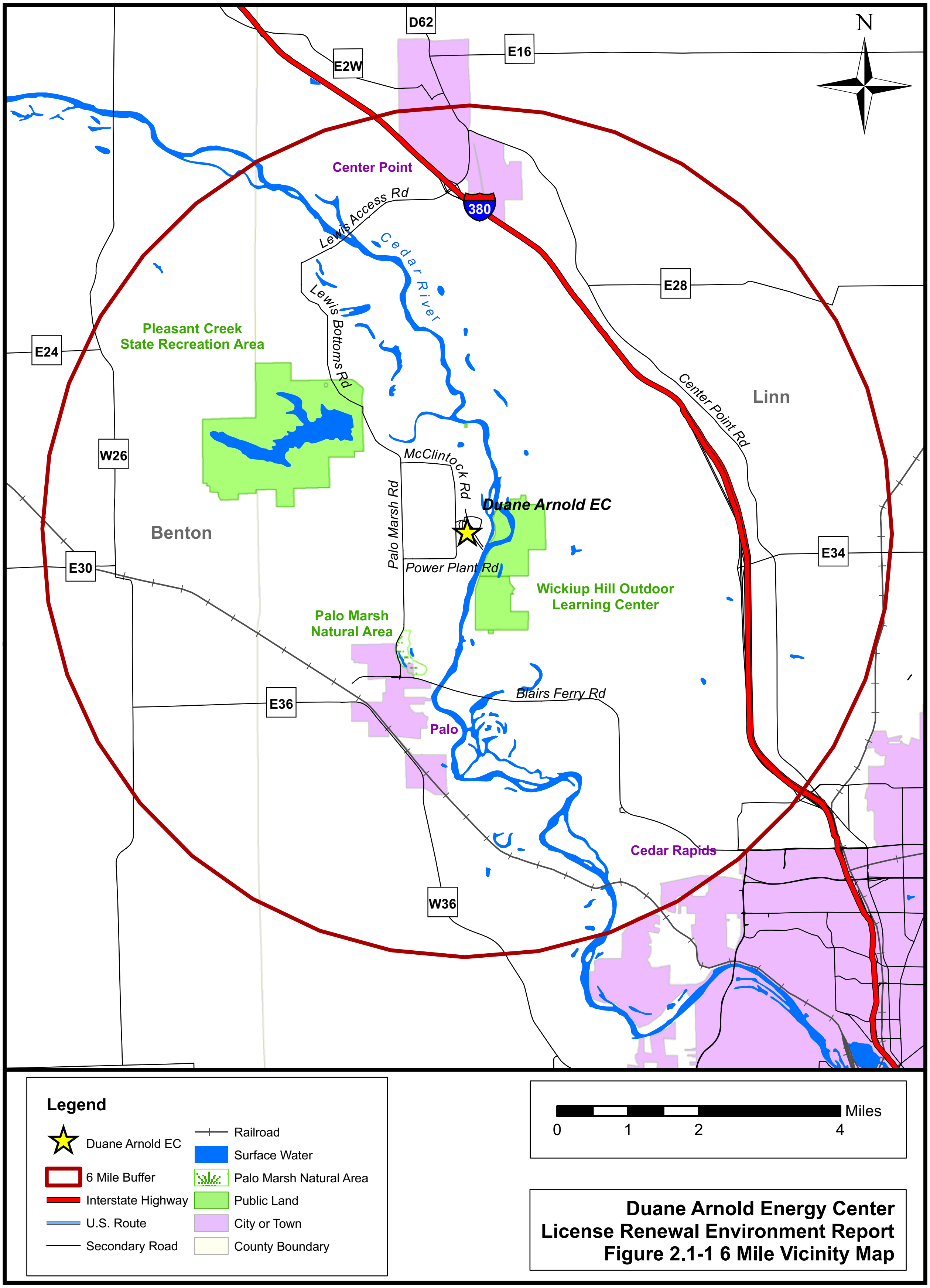
The general topographical features in this portion of the Cedar River consist of broad valleys with relatively narrow flood plains. In many places, these broad valleys merge almost imperceptibly into the adjacent uplands. Away from the immediate vicinity of the river, the land is gently rolling farmland.

TRANSMISSION LINE CORRIDORS

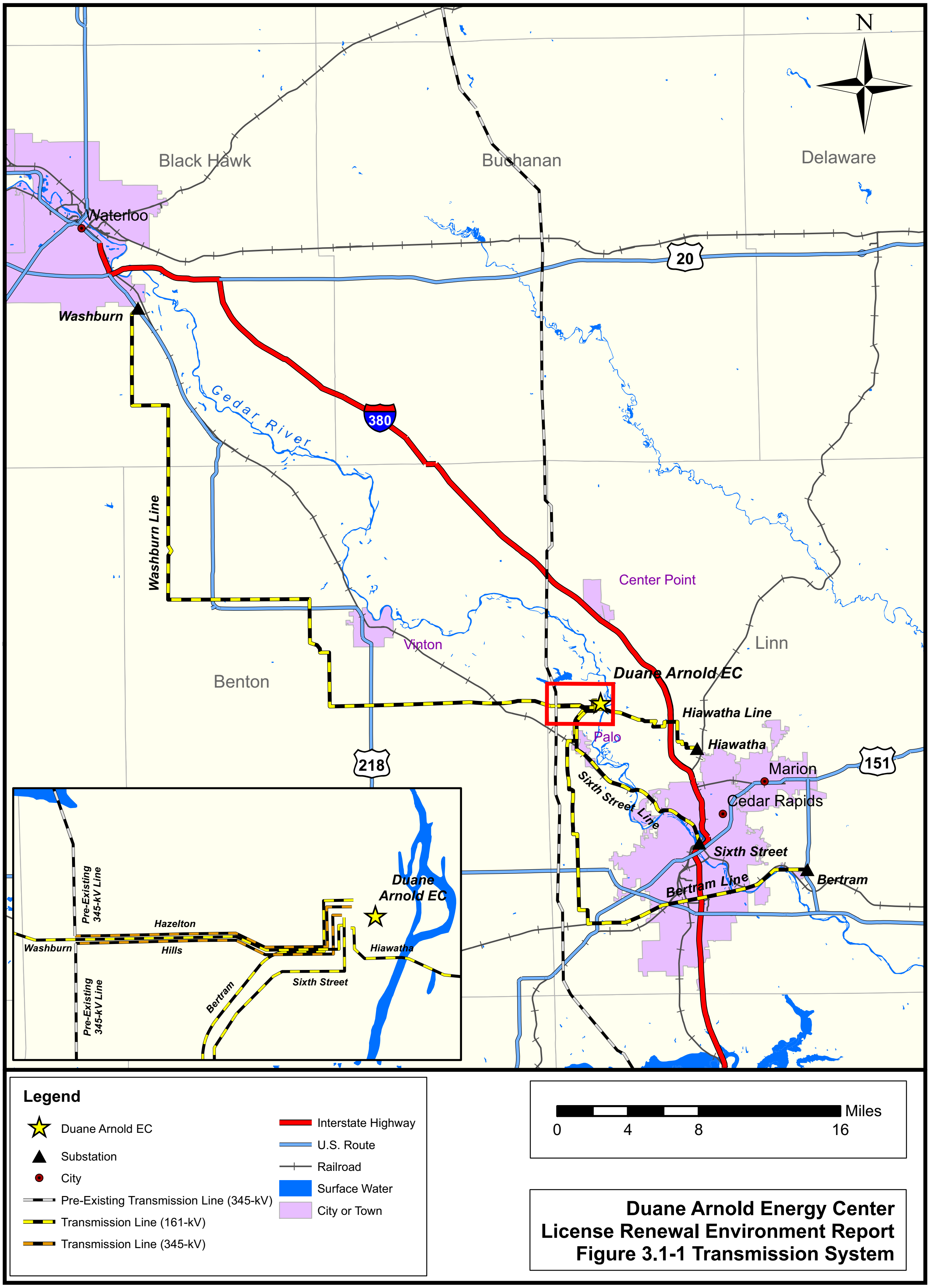
Five transmission-line systems extend westward in a 665-ft corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near this road, two 161-kV lines departs and continue within a corridor of 100-ft basic width (generally narrower along railroad and public rights-of-way) in a southerly direction. At the village of Palo, one of these lines follows a railroad right of way southeastly 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 in a 500-ft 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.



Duane Arnold Energy Center
License Renewal Environmental Report
Figure 2.1-3 Site Boundary Map



Duane Arnold Energy Center
License Renewal Environment Report
Figure 2.1-1 6 Mile Vicinity Map



Duane Arnold Energy Center
License Renewal Environment Report
Figure 3.1-1 Transmission System

APPENDIX E PUBLIC HEALTH AGENCY CORRESPONDENCE

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FPL Energy
Duane Arnold Energy Center

FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

April 13, 2007
NG-07-0231

Mary Mincer Hansen RN PhD, Director
Iowa Department of Public Health
321 E. 12th Street
Des Moines, Iowa 50319-0075

Subject: FPL Energy Duane Arnold, LLC*
License Renewal Project
NRC Informal Consultation Preparation

Dear Dr. Mincer Hansen:

FPL Energy Duane Arnold, LLC is preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license of the facility for an additional twenty years. We intend the application to be consistent with your agencies' interests and the priorities of our community. Although Duane Arnold's current operating license does not expire until February 2014, the NRC's rigorous license renewal process and other regulatory reviews make it prudent for us to submit this application for license renewal to the NRC in late 2008.

As a part of the license renewal process, the Nuclear Regulatory Commission (NRC) requires that applicants identify impacts to public health resulting from the continued operation of the plant and cooling towers. Potential impacts may include: microorganisms associated with cooling tower and thermal discharges, and radiological health. This assessment, which will be contained in the Environmental Report submitted as part of the application, will address specific environmental issues related to the continued operation of the Station during the license renewal period. Following our submission of the application, the NRC will request an informal consultation with your office with respect to the matters referenced in this letter.

It is our intent that, by contacting you at this point in the process, we can identify any deficiencies, concerns, or data needed so that those areas identified can be addressed to assure that the consultation process proceeds smoothly and efficiently.

Based on our preliminary assessment, the continued operation of Duane Arnold during the license renewal period would not be expected to adversely affect the environment within the vicinity of the station. FPL Energy Duane Arnold currently has no plans to alter operations over the license renewal period and any maintenance activities necessary to support license renewal would be limited to previously disturbed areas on-site. Finally, no expansion of existing facilities is planned and no additional land disturbance is anticipated in support of license renewal.

After your review, we would appreciate a letter affirming FPL Energy Duane Arnold's conclusion. To assist you in responding to this request, I have enclosed a site description and figures depicting the site and near vicinity.

If you have any comments or questions, seek any specific data or desire a presentation to further explain the license renewal process, please contact:

Herb Giorgio
3277 DAEC Rd
Palo IA 52324
Herb_Giorgio@fpl.com
(319) 851.7264.

Sincerely yours,

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold, LLC

Enclosures:
Duane Arnold Site Description
Duane Arnold Site Boundary Map
Duane Arnold 6 Mile Vicinity Map
Duane Arnold Transmission System

* FPL Energy Duane Arnold LLC is a Delaware Limited Liability Company, acting for itself and as agent for Central Iowa Power Cooperative and Corn Belt Power Cooperative.

Duane Arnold Site Description

SITE DESCRIPTION

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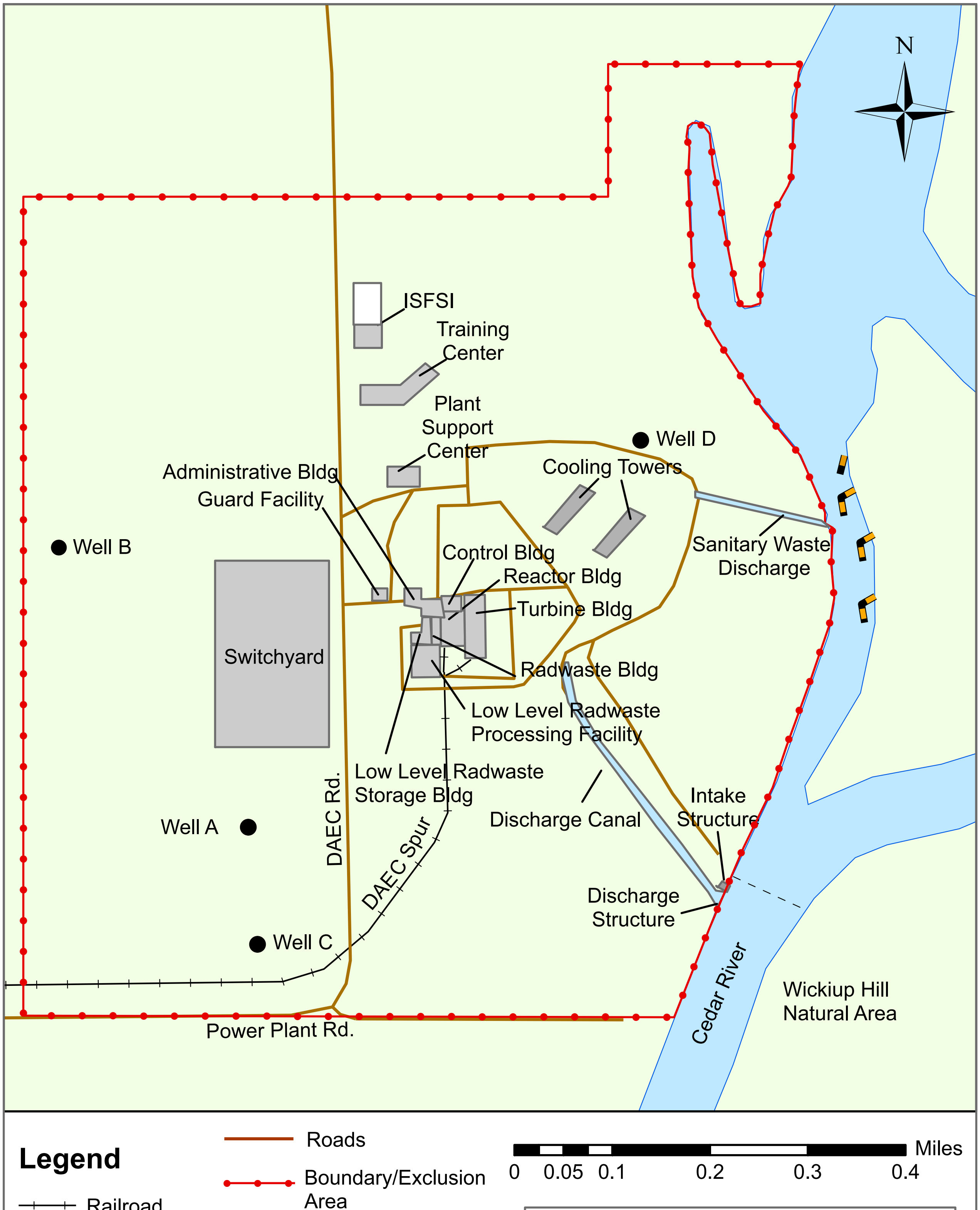
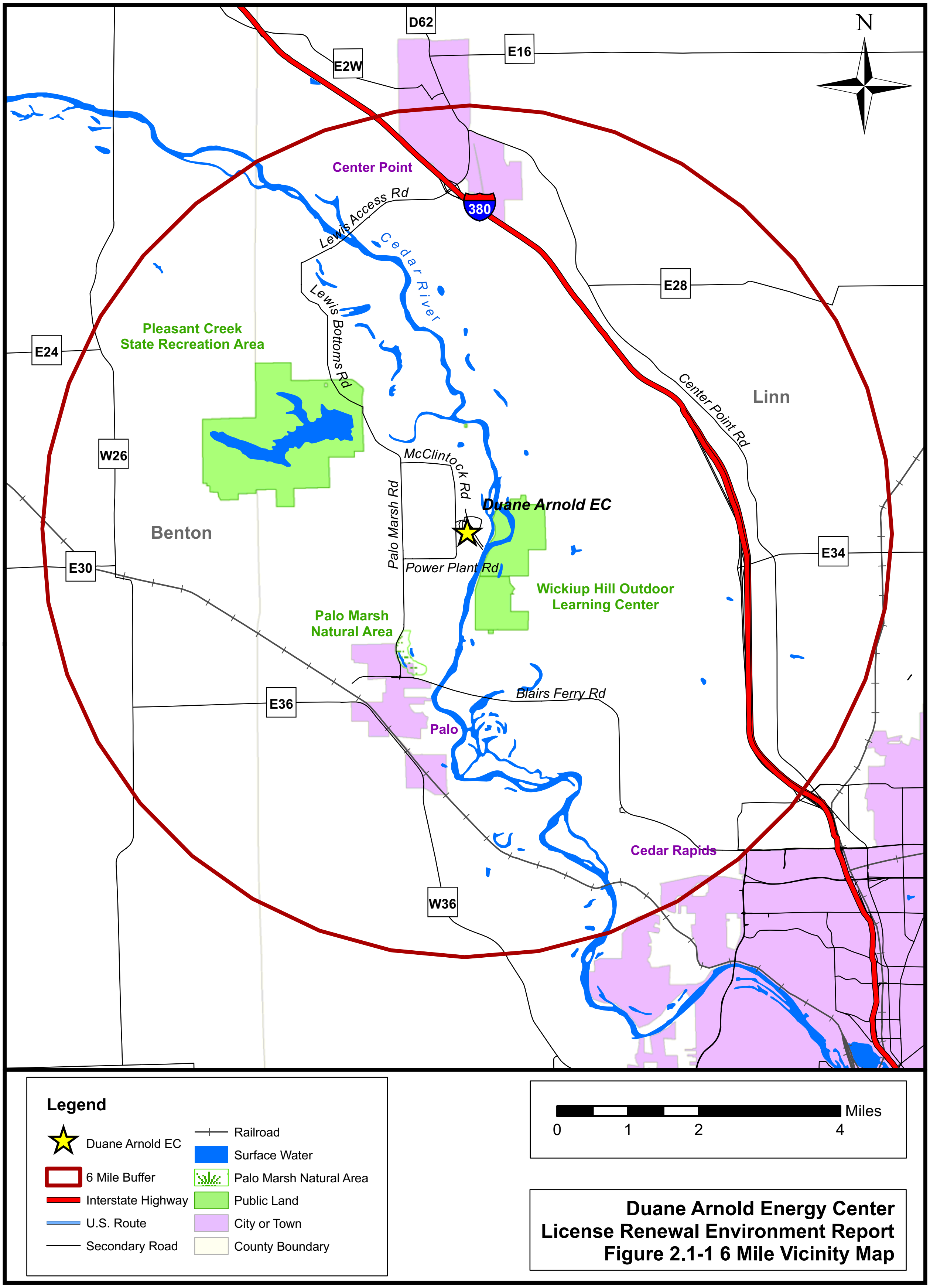


Duane Arnold Energy Center
License Renewal Environmental Report
Figure 2.1-3 Site Boundary Map



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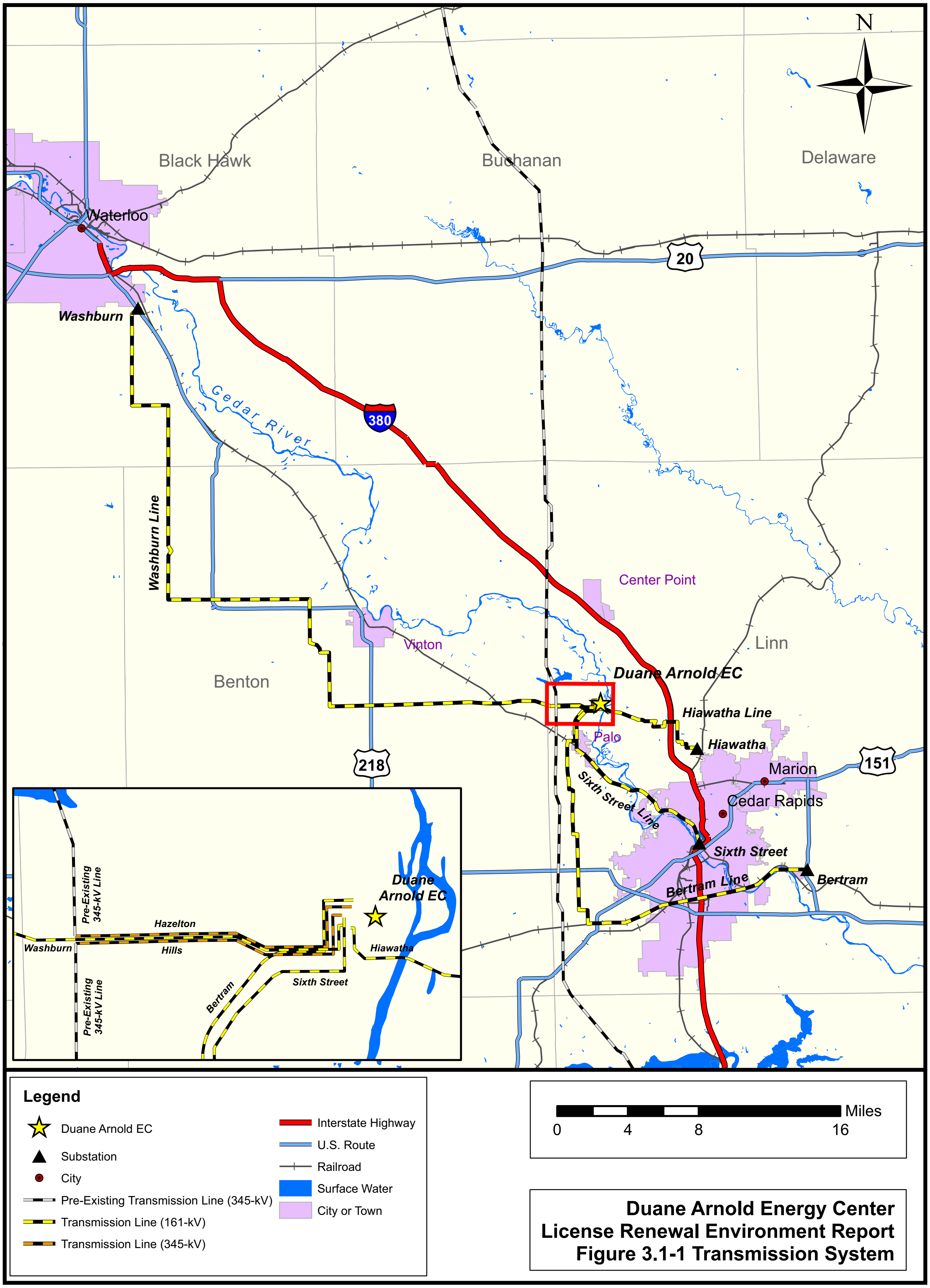

Duane Arnold Energy Center
License Renewal Environment Report
Figure 3.1-1 Transmission System

Iowa Department of Public Health
Advancing Health Through the Generations

Chester J. Culver	Patty Judge	Thomas Newton, MPP, REHS
Governor	Lt. Governor	Director

November 1, 2007

Gary Van Middlesworth
Vice President
FPL Energy Duane Arnold
3277 DAEC Road
Palo, IA 52324

Dear Mr. Van Middlesworth:

We have reviewed the "Environmental Report, Preliminary Draft, August 2007," an enclosure to your letter, dated October 2, 2007, to Tom Newton, Director, Iowa Department of Public Health. In that letter you requested that we review the draft report and affirm via letter whether we agree with FPL Energy Duane Arnold's conclusions.

We agree, provided that no substantive changes are made to the draft document, the "operation of the Station or use of the cooling towers" does not negatively impact public health.

If you have any questions, please contact Melanie Rasmusson (515-281-3478) or me.

Sincerely,

Ken Sharp

Ken Sharp, Division Director
Environmental Health Division
Iowa Dept. of Public Health
(515) 281-5099

Lucas State Office Building, 321 E. 12th Street, Des Moines, IA 50319-0075 ■ 515-281-7689 ■ www.idph.state.ia.us
DEAF RELAY (Hearing or Speech Impaired) 711 or 1-800-735-2942

APPENDIX F SAMA ANALYSIS

EXECUTIVE SUMMARY

This report provides an analysis of the Severe Accident Mitigation Alternatives (SAMAs) that were identified for consideration by the Duane Arnold Energy Center (DAEC). This analysis was conducted on a cost/benefit basis. The benefit results are contained in Section 4 of this report. Candidate SAMAs that do not have benefit evaluations have been eliminated from further consideration for any of the following reasons:

- The cost is considered excessive compared with benefits.
- The improvement is not applicable to DAEC.
- The improvement has already been implemented or the intent of the improvement is met for DAEC.

After eliminating a portion of the SAMAs for the preceding reasons, the remaining SAMAs were evaluated from a cost-benefit perspective. In general, the SAMAs were examined using a bounding analysis approach to determine whether the expected cost would exceed a conservative approximation of the actual expected benefit. In most cases, therefore, a detailed risk evaluation in which a specific modification/procedure change is evaluated would indicate a smaller benefit than calculated in this evaluation.

Major insights from this benefit evaluation process included the following:

- If all core damage risk is eliminated, then the benefit in dollars over 20 years is $2,261,022.
- The largest contributors to the total benefit estimate are from offsite costs.
- A large number of SAMAs had already been addressed by existing plant features, modifications to improve the plant, existing procedures, or procedure changes to enhance human performance.

The following SAMAs were identified as potentially cost beneficial.

DAEC SAMA Number	Potential Improvement	Discussion
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ADS	Automatic Depressurization System
AOV	Air Operated Valve
ATWS	Anticipated Transient Without Scram
CDF	Core Damage Frequency
CRD	Control Rod Drive
DAEC	Duane Arnold Energy Center
ED	Emergency Depressurization
EDG	Emergency Diesel Generator
EOP	Emergency Operating Procedure
EPZ	Emergency Planning Zone
FIVE	Fire-Induced Vulnerability Evaluation
FHA	Fire Hazard Analysis
GSW	General Service Water
HCLPF	High Confidence Low Probability Of Failure
HEP	Human Error Probabilities
HPCI	High Pressure Coolant Injection
LPCI	Low Pressure Coolant Injection
IORV	Inadvertent Open Relief Valve
ISLOCA	Interfacing System loss of Coolant Accident
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination For External Events
LERF	Large Early Release Frequency
LOCA	Loss Of Coolant Accident
LOOP	Loss Of Off-Site Power
MCC	Motor Control Center
MOV	Motor Operated Valve
MSIV	Main Steam Isolation Valve
NEI	Nuclear Energy Institute
NUMARC	National Water Quality Assessment
PRA	Probabilistic Risk Assessment
RCIC	Reactor Core Isolation Cooling
RBCCW	Reactor Building Closed Cooling Water
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RPV	Reactor Pressure Vessel
RRW	Risk Reduction Worth

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RWCU	Reactor Water Cleanup
SAMA	Severe Accident Mitigation Alternatives
SBDG	Standby Diesel Generators
SBLC	Standby Liquid Control
SBO	Station Blackout
SQUG	Seismic Qualification Utility Group
SMA	Seismic Margins Assessment
SORV	Stuck Open Relief Valve
SSEL	Seismic Safe Shutdown Equipment List
TAF	Top of Active Fuel
VDC	Volts DC

1 INTRODUCTION

1.1 PURPOSE

The purpose of the analysis is to identify SAMA candidates at DAEC that have the potential to reduce severe accident risk and to determine whether implementation of the individual SAMA candidate would be cost beneficial. NRC license renewal environmental regulations require SAMA evaluation.

1.2 REQUIREMENTS

- 10 CFR 51.53(c)(3)(ii)(L)
  - The environmental report must contain a consideration of alternatives to mitigate severe accidents "…if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environment assessment..."
- 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 76
  - "…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…."

2 METHOD

The SAMA analysis approach applied in the DAEC assessment consists of the following steps.

- **Determine Severe Accident Risk**

Level 1 and 2 Probabilistic Risk Assessment (PRA) Model
The DAEC PRA (FPL 2007b) model (Section 3.1 – 3.2) was used as input to the DAEC Level 3 PRA analysis (Section 3.4).

The Level 1 PRA results include the risk from internal and external events. The external hazards evaluated in the PRA are internal fires and seismic events only; this evaluation was done for the IPEEE program. High winds and tornadoes, external floods, and transportation and nearby facility accidents are not included in the results since they were screened from the IPEEE submittal because their individual CDF fell below the cutoff criteria of 1.0E-06 per year. The external events are not propagated through the Level 2 analysis.

Level 3 PRA Analysis
The Level 1 and 2 PRA output and site-specific meteorology, demographic, land use, and emergency response data was used as input for the DAEC Level 3 PRA (Section 3). This combined model was used to estimate the severe accident risk, i.e., off-site dose and economic impacts of a severe accident.

- **Determine Cost of Severe Accident Risk / Maximum Benefit**

The NRC regulatory analysis techniques to estimate the cost of severe accident risk were used throughout this analysis. These techniques were used to estimate the maximum benefit that a SAMA could achieve if it eliminated all risk, i.e., the maximum benefit (Section 4).

- **SAMA Identification**

In this step potential SAMA candidates (plant enhancements that reduce the likelihood of core damage and/or reduce releases from containment) were identified by DAEC plant staff, from the PRA model, Individual Plant Examination (IPE), IPE – External Events (IPEEE) recommendations, and industry documentation (Section 5). This process included consideration of the PRA importance analysis because SAMA candidates are not likely to prove cost-beneficial if they only mitigate the consequences of events that present a low risk to the plant.

- **Preliminary Screening (Phase I SAMA Analysis)**

Because many of the SAMA candidates identified in the previous step are from the industry, it was necessary to screen out SAMA candidates that were not applicable to the DAEC design, candidates that had already been implemented or whose benefits have been achieved at the plant using other means, and candidates whose first level cost estimate exceeded the maximum benefit. Additionally, PRA insights (specifically, importance measures) were used directly to screen SAMA candidates that did not address significant contributors to (Section 6).

- **Final Screening (Phase II SAMA Analysis)**

The benefit of severe accident risk reduction was estimated for each of the remaining SAMA candidates and compared to an implementation cost estimate to determine net cost-benefit (Section 7). The benefit associated with each SAMA was determined by the reduction in severe accident risk from the baseline derived by modifying the plant model to represent the plant after implementing the candidate. In general, the modeling approach used was a bounding approach to first determine a bounding value of the benefit. If this benefit was determined to be smaller than the expected cost, no further modeling detail was conducted. If the benefit was found to be greater than the estimated cost, the modeling was refined to remove conservatism and a more accurate benefit was determined for comparison with the estimated cost.

Similarly, the initial cost estimate used in this analysis was obtained from an Expert Panel consisting of plant staff familiar with design, construction, operation, training and maintenance. All costs associated with a SAMA were considered, including design, engineering, safety analysis, installation, and long-term maintenance, calibrations, training, etc. If, after removing the conservatism in the benefit calculation, the estimated cost and benefit were still close, then the cost estimate was reviewed by a member of Design Engineering to assure it was sufficiently accurate to justify further consideration of the SAMA via the Corrective Actions Request process.

- **Sensitivity Analysis**

The next step in the SAMA analysis process involved evaluating the impact of changes in SAMA analysis assumptions and uncertainties in the cost-benefit analysis (Section 8).

- **Identify Conclusions**

The final step involved summarizing the results and conclusions (Section 9).

3 SEVERE ACCIDENT RISK

The DAEC PRA models describe the results of the first two levels of the PRA for the plant. Level 1 determines CDFs based on system analyses and human reliability assessments; while Level 2 evaluates the impact of severe accident phenomena on radiological releases and quantifies the condition on the containment and the characteristics of the release of fission products to the environment. The DAEC models use PRA techniques to:

- Develop an understanding of severe accident behaviors,
- Understand the most likely severe accident consequences,
- Gain a quantitative understanding of the overall probabilities of core damage and fission product releases, and
- Evaluate hardware and procedure changes to assess the overall probabilities of core damage and fission product releases.

The DAEC PRA program was initiated in response to Generic Letter 88-20 (NRC 1988), which resulted in the DAEC Independent Plant Examination (IPE) (IELP 1992) and IPE for External Events (IPEEE) (IES 1995) analyses. DAEC has a Level 1 Internal Events PRA model, a Level 2 Internal Events model and a Level 1 External Events model. Internal flooding is considered in the Level 1 and Level 2 models. Fire and Seismic initiated events are considered external events. Potential impact from other external events, such as high winds and tornadoes, external floods, and offsite facilities were determined to be non-risk significant in the Individual Plant Examination for External Events.

The PRA models used to calculate severe accident risk are described in this section. The Level 1 PRA model (internal and external), the Level 2 PRA model, the PRA model review history, and the consolidated Level 3 PRA model are described in Section 3.1, 3.2, 3.3 and 3.4 respectively. All results are based on sequence by sequence runs using PRAQuant (EPRI 2005).

3.1 LEVEL 1 PRA MODEL

The Level 1 PRA model used for the SAMA analysis was Revision 5C. As part of the DAEC design process, plant modifications are screened for impact on the PRA. If necessary, the PRA model is upgraded to include the plant modification. This screening process identified no modifications which would affect the results of the SAMA study. Thus, no changes were made to the current Level 1 PRA model to accommodate the SAMA analysis.

3.1.1 Internal Events

3.1.1.1 Description of Level 1 Internal Events PRA Model

The Level 1 Internal Events PRA model uses the PRAQuant batch processor and the FORTE quantification engine to quantify individual accident sequences. In the case of the Level 1 PRA, the ONE4ALL utility code was used to also develop a single-top model. These are all members of the EPRI R&R Workstation suite of PRA codes.

The total internal events CDF for DAEC is calculated to be 1.08E-05 per year using the single top model and a truncation limit of 1E-11. The top six initiating events based on the Fussell-Vesely importance measure are:

1. Loss of Offsite Power (37%)
2. Turbine Trip with Bypass (15%)
3. MSIV Closure (13%)
4. Inadvertent Open Relief Valve (11%)
5. Loss of Condenser Vacuum (6%)
6. Loss of Div 2 125 Volt DC Power (3%)

Anticipated Transient Without Scram (ATWS) is not treated as an initiating event in the DAEC PRA model. Rather, it is treated as a potential consequence of other initiating events. ATWS accident sequences account for 29% of the total internal events CDF.

The top 10 risk significant systems based on the Fussell-Vesely importance measure are:

1. Normal AC Power
2. Emergency AC Power
3. CRD Hydraulic / RPS
4. 125 Volt DC Power

5. Standby Liquid Control
6. Reactor Core Isolation Cooling
7. River Water Supply
8. High Pressure Coolant Injection
9. Residual Heat Removal
10. RHR Service Water

The top 10 risk significant operator actions based on the Fussell-Vesely importance measure are:

1. Operator Fails to Inject SBLC Early (Within 4 Minutes)
2. Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)
3. Operator Fails to Vent Containment Per EOPs
4. Operator Fails to Prevent Overfilling RPV
5. Operator Fails to Recover Torus Cooling
6. Operator Fails to Lower RPV Level to TAF for ATWS Pwr Cntrl
7. Operator Fails to Inhibit ADS (ATWS with High Press Inj)
8. Operator Fails to Restore RPV Level Post ED (ATWS)
9. Operator Fails to Recover Main Condenser
10. Operator Fails to Manually Initiate ADS (Non-Med LOCA)

Table 3.1.1.1-1 provides the list of PRA contributors that are most important from the perspective of risk reduction. This table includes all those contributors having a risk reduction worth of 1.005 or greater.

Table 3.1.1.1-1 Dominant Contributors to Risk Reduction

Contributor	RRW	Description
B-OPSLCE---U	1.099	Operator Fails to Inject SBLC Early (Within 4 Minutes)
FTPE-Q4--Q4-	1.059	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)
PDI1947	1.053	This represents failure of the RHRSW Loop 'B' HX Diff Press Indicator
V-OPTORVENTU	1.053	Operator Fails to Vent Containment Per EOPs
FTPE-L---L--	1.053	Operator Fails to Prevent Overfilling RPV
L2OPNOREC--U	1.049	Operator Fails to Recover Torus Cooling
FTPE-L1--L1-	1.042	Operator Fails to Lower RPV Level to TAF for ATWS Pwr Cntrl
E/P4914	1.033	Control Air Supply E/P converter for CV4914
CB8490	1.033	This term represents failure of Switchyard Control Breaker "M". SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
FTPE-X---X--	1.031	Operator Fails to Inhibit ADS (ATWS with High Press Inj)
FTPE-L2--L2-	1.030	Operator Fails to Restore RPV Level Post ED (ATWS)
C-OPNOREP--U	1.029	Operator Fails to Recover Main Condenser
1G031	1.029	This represents failure of the Div 1 Standby Diesel Generator. SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
E/P4915	1.028	Control Air Supply E/P converter for CV4915
1G021	1.028	This represents failure of the Div 2 Standby Diesel Generator. SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
1P216	1.025	This represents failure of the HPCI Pump/Turbine. SAMAs 27, 28, 29, 31, 33, 34 evaluate improvements that would reduce the risk of high pressure injection failures.
O-OPMANDEP-U	1.023	Operator Fails to Manually Initiate ADS (Non-Med LOCA)
FTPE-LA--LA-	1.023	Operator Fails to Prevent Overfilling RPV
FTPE-TR--TR-	1.018	Operator Fails to Bypass HPCI/RCIC Low RPV Press Trip
L-OPCHRTRNSY	1.017	Operator Fails to Follow EOPs for Cont. Ht. Removal
V-OPVENTTRNY	1.017	Operator Fails to Vent Torus (Transients/LOCA)
C-OPCD03---U	1.017	Operator Fails to Open an MSIV and/or Bypass Valve
B-OPSLCLAT3U	1.016	Operator Fails to Inject SBLC Early (Within 14 Minutes)
PS4529	1.016	RPV Low Pressure Permissive for LPCI/CS
PS4545	1.016	RPV Low Pressure Permissive for LPCI/CS
FTPE-Q3--Q3-	1.014	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)
1A311	1.013	This represents failure of the SBDG 1G031 to Bus 1A3 Circuit Breaker. SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard. SAMA 23 evaluates the risk due to breaker failures.
1A411	1.013	Failure of the SBDG 1G021 to Bus 1A4 Circuit Breaker. SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard. SAMA 23 evaluates the risk due to breaker failures.

Table 3.1.1.1-1 Dominant Contributors to Risk Reduction (Cont.)

Contributor	RRW	Description
C-OPALTINJ-U	1.013	Operator Fails to Initiate Condensate for Alt Inj
W-OPWS04---U	1.013	Operator Fails to Open CV4914
W-OPWS02---U	1.012	Operator Fails to Open CV4915
FTPE-XA--XA-	1.012	Operator Fails to Inhibit ADS (ATWS with No High Press Inj)
I-OPLRESPERX	1.011	Miscalibration of Low Press Permiss Instrumentation
H-OP14-----U	1.011	Operator Fails to Shutoff HPCI or RCIC
1T218	1.011	Failure of the SBLC Storage Tank. SAMAs 118, 119 evaluate alternate means of boron injection in ATWS.
1P226	1.010	Failure of the RCIC Turbine/Pump. SAMAs 27, 28, 29, 31, 33, 34 evaluate improvements that would reduce the risk of high pressure injection failures.
PS4530	1.010	RPV Low Pressure Permissive for LPCI/CS
PS4548	1.010	RPV Low Pressure Permissive for LPCI/CS
Q-OPLEVEL-TT	1.009	Operator Fails to Cntrl Rx Level Following Scram
Z-OPWELLWTRU	1.009	Operator Fails to Maximize Well Water to Circ Pit
FTPE-X1--X1-	1.008	Operator Fails to Manually Depressurize RPV (ATWS)
L-OPCHRATWSY	1.008	Operator Fails to Follow EOPs for Cont. Ht. Removal
Q-OPFW99--LU	1.008	Operator Fails to Initiate Feedwater (Large LOCA/ATWS)
P-OPBCREC--Y	1.007	Operator Fails to Recover Battery Charger
O-OPMNDPML-U	1.006	Operator Fails to Manually Initiate ADS (Medium LOCA)
U-OP2NOREPRS	1.006	Operator Fails to Repressurize RPV for HPCI
W-OPFFWS03--	1.005	Operator Fails to Open CV4910B
W-OPFFWS04--	1.005	Operator Fails to Open CV4910A
G-OPLOCSTRTU	1.005	Operator Fails to Close Breaker to Start GSW Pump
HS4914	1.005	Failure of the RWS Loop 'B' Makeup Hand Switch
PDI2046	1.005	Failure of the RHRSW Loop 'A' HX Diff Press Indicator

3.1.1.2 Level 1 PRA Model Changes since IPE Submittal

The major Level 1 changes incorporated into the updated DAEC model since the 1992 IPE Submittal are described as follows:

Revisions 3 (aka 3A) and 3B, April and October 1995, respectively

- Incorporation of Design and Procedural changes since the IPE freeze date through January 1994,
- Inclusion of control building flood event trees,
- Revision to HPCI/RCIC battery life estimates,
- Reclassification of DAEC offsite power independence group from L1 to L2,
- Re-evaluation of the LOOP initiator,
- Incorporation of the Manual Shutdown event tree,
- Incorporation of the LOCA Outside of Containment event tree,
- Revision of the RPV water level and pressure instrumentation to reflect the correct mission time for transmitters failure probabilities,
- Incorporation of changes resulting from the PSA QA program,
- Addition of house events and flag settings to facilitate batch file capability and automation of fault tree quantification,
- Modification of fault tree and event tree culling limits to reduce quantification of less significant cut sets,
- Incorporation of a revised control building HVAC assessment,
- Incorporation of sole dependence of DC power on 125 VDC batteries given a LOOP or LOCA initiator,
- Modification of success criteria for SORV cases,
- Addition of maintenance basic events.

Revision 4 (aka 4A), March 1998

- Essential Switchgear rooms' ventilation requirement relaxed,
- ADS Suppression added as a means for vapor suppression,
- Allowance for failure of DHR upon success of HPCI / RCIC in small LOCA event tree sequences,
- Addition of credit for River Water Supply Recovery,
- Sequences for Loss of Offsite Power events with subsequent failure to re-close SRVs categorized as LOOP to IORV,
- Added Credit for Drywell Venting,
- Revision of event trees for Human Error Probabilities or Containment heat removal,
- Added credit for procedures dealing with total loss of 125VDC,
- Incorporated initiating event frequencies for transients and manual shutdown,
- Addition of Several Maintenance Unavailability Terms,
- Inclusion of modification to the Well Water System Design,
- Inclusion of Common Cause Failure for SRVs,

- Updated maintenance unavailability rates from the Maintenance Rule database,
- Added an explicit model of the important transformers, control breakers, and power source lines.

Revision 4B, March 1998
- Conversion from REBECA to CAFTA.

Revision 5 (aka 5A), October 2003
- Updated several Human Error Probabilities (HEPs) as a result of the plant's power uprate,
- Numerous basic event nomenclature and failure probability changes were made in order to make the failure rates more traceable and make the nomenclature more self-consistent,
- Loss of offsite power initiator frequency was updated to reflect plant operating experience since the last PRA update,
- Added a fault tree for the instrument air system,
- Modification to the modeling of the CV4909 River Water radwaste dilution isolation valve,
- Incorporated changes with smaller impacts on CDF as a result of BWROG PSA Certification team comments.

Revision 5B, February 2005
- ESW/RHRSW pumphouse ventilation dependency added to ESW fault tree,
- Explicit fault tree modeling of Recirculation Pump Trip failure rather than a single point estimate value,
- Basic event nomenclature and failure probability changes were made,
- Loss of offsite power initiator frequency was updated to be consistent with the plant station blackout (SBO) analysis.

Revision 5C, July 2007
- Eliminated the use of quantification flag setting from the Base Rev 5B Level 1 internal events model to correct a quantification error.

Since the 1992 IPE submittal, the CDF has changed in the following manner:

Changes in Internal CDF / Year Since 1992 IPE Submittal

	1992 IPE Submittal	Rev 3A (3/95)	Rev 3B (8/95)	Rev 4A (3/98)	Rev 4B (12/01)	Rev 5A (10/03)	Rev 5B (2/05)	Rev 5C (7/07)
Total	7.84E-06	3.30E-05	1.50E-05	1.11E-05	1.19E-05	1.02E-05	1.07E-05	1.09E-05
LOOP	2.93E-06	2.53E-05	7.27E-06	5.90E-06	6.37E-06	3.71E-06	3.75E-06	3.82E-06
ATWS	1.91E-06	3.30E-06	3.30E-06	2.02E-06	1.97E-06	3.11E-06	3.15E-06	3.15E-06

3.1.2 External Events

The current DAEC External Events PRA explicitly models internal fire and seismic initiated core damage accidents. These models are based on the original DAEC IPEEE

(Individual Plant Examination of External Events) Submittal which showed fire and seismic events to be the most significant external hazards with respect to calculated CDF.

The fire and seismic accident sequence logic was incorporated into the internal events PRA system fault tree logic.

The External Events PRA CDFs (based on PRAQuant sequence results) are as follows:

- Total External Events CDF: 3.74E-06/yr
  - Internal Fires 3.04E-06/yr
  - Seismic 6.99E-07/yr

Prior to 1997, the risks associated with external events were assessed on a room by room basis. No comprehensive CDF was developed. In 1997 DAEC created a living External Events Model which includes the calculation of an overall CDF for external events. The CDF for external events is re-calculated following a major revision (e.g., from version 4 to 5) or minor revision (e.g., 5A to 5B) to the Level 1 internal events PRA. Starting in December of 2001, the External Events CDF was calculated at the same time as the Internal Events CDF. The changes in the External Events CDF are as follows:

Changes in External Events CDF / Year Since 1997 Model Development

Corresponding Level 1 Revision	Rev 3B	Rev 4A	Rev 4B	Rev 5A	Rev 5B	Rev 5C
External Events Revision Date	Feb-97	Jun-99	Dec-01	Oct-03	Feb-05	Jul-07
Total	3.85E-06	3.68E-06	3.82E-06	3.83E-06	3.74E-06	3.74E-06
Fire	2.81E-06	2.98E-06	3.12E-06	3.13E-06	3.04E-06	3.04E-06
Seismic	1.04E-06	7.04E-07	7.00E-07	7.04E-07	6.99E-07	6.99E-07

There are no outstanding recommendations related to external events with respect to potential improvements and strategies described in the DAEC IPEEE submittal.

3.1.2.1 Internal Fires

3.1.2.1.1 Current Model

Modeling the external events fire sequences consists of three main steps:

- Determining the fire ignition frequency for each fire compartment;
- Performing fire growth and suppression analysis; and
- Determining the fire-induced CDF.

The individual fire compartment fire ignition frequencies used are taken from the DAEC IPEEE Fire-Induced Vulnerability Evaluation (FIVE) (PLC 1992) analysis. Fire compartments that had fire core damage frequencies of 2.5E-8/yr or more in the FIVE IPEEE analysis are analyzed further in the external events analysis.

The fire initiating event frequencies are used as input into the fire growth and suppression event trees. The analysis determines the probability that a fire will damage at least one piece of equipment in the room as well as the probability that all equipment in the room is destroyed.

These probabilities then serve as inputs into the fire-induced core damage event trees which determine the core damage frequencies due to fire for each fire compartment.

3.1.2.1.2 Original IPEEE Model

The original IPEEE utilized the FIVE methodology to identify fire areas of potential risk significance, calculated area fire ignition frequencies, and provided hazards analysis for resulting critical areas. This methodology provided a conservative analysis process that utilized existing plant analyses, such as the DAEC Fire Hazard Analysis (FHA) (ERIN 1995a) and the DAEC Level 1 PRA.

This evaluation consisted of three phases: The Phase I screening involved the identification of plant fire areas and a qualitative assessment of the consequences of a fire in these areas. Phase II was a progressive probabilistic evaluation that considered the sequence of events which must occur to prevent safe shutdown. It allowed fire areas to be screened from further analysis once the frequency of fire initiated core damage accident sequences dropped below 1E-06/yr. Phase III consisted of a walkdown and verification process to determine whether or not the assumptions and calculations of the evaluation were supported by the physical conditions of the plant. These walkdowns were performed concurrently with activities in the first two phases.

The analyses determined that credible fire events had an acceptably low frequency of causing core damage. The two essential 4kV switchgear rooms had the highest contribution to the fire induced core damage frequency and were reportable per the NRC criterion of a CDF greater than 1E-06/yr. A postulated fire in either of the essential 4kV switchgear rooms had the potential to result in loss of all divisional AC powered plant equipment supported by the respective essential switchgear. The consequences of such an occurrence were evaluated by propagating the postulated failure through the DAEC Level 1 PSA models. The results of this process showed that complete loss of the decay heat removal function is the dominant challenge to plant safety.

Postulated fire events in all other areas of the plant did not represent significant contributors to core damage frequency.

The DAEC fire suppression system was reviewed against the recommendations of IN 94-12 (NRC 1994a) to assess the effects of fire protection system actuation on safety related equipment. The DAEC fire suppression system was determined to be configured and maintained to minimize the risk of safety system failure due to inadvertent suppression system operation. DAEC has routinely designed and located fire protection system components and/or shielded safety equipment cognizant of the issue of inadvertent or advertent actuations. As Part of this review, a 1985 Bechtel study to address fire suppression actuation effects with respect to Appendix R safe shutdown (IELP 1985) were verified as complete.

A walkdown undertaken in support of the IPEEE identified a potentially dominant core damage sequence related to the fire suppression sprinkler piping for the Control Building HVAC room located above the Control Room. Rupture of pipe walls or fittings of the fire suppression piping could lead to flooding of the essential switchgear rooms via an HVAC shaft. A modification was implemented to turn these two wet pipes into dry pipes with isolation valves. Procedures were also modified to direct operations personnel to open the isolation valves upon receipt of smoke or heat detector alarms initiated from the HVAC room.

3.1.2.2 Seismic Events

3.1.2.2.1 Current Model

Modeling the external events seismic sequences consists of three main steps:

- Seismic hazard analysis
- Seismic capacity and fragility analysis
- Seismically-induced core damage frequency analysis

The seismic hazard analysis uses seismic hazard curves developed by Lawrence Livermore National Laboratory (NRC 1994b) to determine the annual exceedance probabilities of various magnitudes of earthquakes at 69 nuclear power plant sites in the United States, including DAEC. These probabilities are used as the input frequencies to seismic event trees.

The seismic core damage sequences are modeled for nine seismic magnitude intervals, ranging from 0.01g to 1.0g and greater. The nine event trees only credit equipment from the Safe Shutdown Equipment List (SSEL) since this was the only equipment credited in the original IPEEE analysis. The exception to this is the torus hard pipe vent system which is not on the SSEL but was installed according to class 1 seismic standards.

The seismic analysis uses High Confidence Low Probability of Failure (HCLPF) values taken from industry studies to determine the probability that SSEL equipment will fail under the nine different magnitudes of seismic ground acceleration. The HCLPF values are used to derive fragility values, which give the probabilities that components will fail given a certain seismic ground acceleration. These fragility values are inserted into modified versions of the various Level 1 system fault trees, such that the seismic fault trees consist of the typical random failures used in the Level 1 PRA, in addition to events that take into account the probability of equipment failure at the nine seismic magnitude intervals due to earthquakes.

3.1.2.2.2 Original IPEEE Model

DAEC participated with a number of utilities to form the Seismic Qualification Utility Group (SQUG) in 1982. The goal of this group was to address Unresolved Safety Issues (USI A-46) and the anticipated generic letter. The SQUG devised a seismic verification plan, referred to as the Generic Implementation Procedure (GIP) that used earthquake experience data and test data to demonstrate the ruggedness of generic classes of equipment. The major elements of GIP were the identification of safe-shutdown equipment and the performance of walkdowns and screening analyses to verify seismic adequacy.

The approach used to address USI A-46 was similar to the approach specified in NUREG-1407 for addressing the seismic IPEEE for reduced-scope seismic margins plants. The two programs are compatible and are efficiently performed together for plants that were required to resolve the A-46 issue as well as conduct seismic margins studies to address the IPEEE. As such, analyses and walkdowns were coordinated to address both the seismic IPEEE and USI A-46.

The Seismic Margins Assessment (SMA) defined in EPRI NP-6041 (EPRI 1991) was used to examine the seismic risk for DAEC and was composed of the following analysis steps:

- Review of plant information and plant walkdowns
- Systems analysis
- Structure response analysis
- Equipment seismic capability analysis
- Containment performance analysis

Approximately eight hundred and fifty (850) items were identified for inclusion in the DAEC Seismic Safe Shutdown Equipment List (SSEL) based on criteria defined in NUREG-1407 and EPRI NP-6041. No equipment outliers were identified with respect to seismic capacity. The majority of the DAEC SSEL equipment items met all applicable requirements of GIP Appendix B’s (SQUG 1991) caveats and inclusion rules. Exceptions were shown to be acceptable by calculation, and those remaining were resolved by maintenance action or modification. Field inspections and ultrasonic testing showed that most SSEL equipment items are well anchored in accordance with Bechtel standard drawings for the plant. Exceptions were shown to be acceptable by calculation, or were resolved by maintenance action or modification. Seismic interaction outliers comprised about 40% of all DAEC SSEL equipment outliers. The majority of seismic interaction outliers were resolved by maintenance action, a few were shown to be adequate by calculation.

With respect to civil structures, four items were addressed in accordance with EPRI NP-6041:

- Masonry walls
- Control Room ceilings
- Category II structures over Category I structures
- Dams, levees, and dikes

One masonry wall was identified during walkdowns as a potential outlier that could fall and damage SSEL equipment. This wall was subsequently qualified for SSE loading. Inspections of the Control Room ceiling members indicated potential outliers with respect to connections and restraint. This issue was subsequently resolved by modifying selected elements of the Control Room ceiling. No outliers were identified with respect to Category II structure failures over Category I structures. No outliers were identified with respect to dams, levees, and dikes.

Seismic induced fire and flood issues were also addressed. Two air handlers in the HPCI room were identified as potential flood/spray outliers due to potential interaction of nearby sprinkler heads with adjacent piping. This outlier was resolved by calculation to show that clearances are sufficient to preclude impact. MCC 1D41 and Control Building HVAC chillers 1VCH001A and B, all located in the reactor building, were identified as potential outliers due to the presence of nearby unanchored gas storage bottles. These outliers were resolved by providing adequate restraint. The diesel-driven fire pump day tank, located in the pump house, was identified as a potential seismic fire outlier due to anchorage concerns. This outlier was shown not to be risk significant due to the large distance and the substantial reinforced-concrete walls between the tank and SSEL equipment. The turbine lube oil storage tank, located in the turbine building, was identified as a potential seismic fire outlier due to inadequate supports. This potential outlier was determined by analysis not to be risk significant.

3.1.2.3 Other External Events

3.1.2.3.1 High Winds and Tornadoes

DAEC Category I structures are designed to withstand a tornado with a horizontal peripheral tangential velocity of 300 mph and a transverse velocity of 60 mph. This is the primary factor in the determination that high wind and tornado risk at DAEC is not significant to overall plant risk.
The total estimated contribution to core damage frequency from high winds and tornadoes is approximately 1.41E-07/yr (IES 1995), which is below the NRC reporting criteria of greater than 1E-06/yr. This is a conservative estimate, as the approach to the quantification is a conservative bounding approach. The analysis performed shows the design of the DAEC plant is appropriate for its siting (i.e., with respect to potential extreme winds) such that the contribution to overall plant risk from extreme winds is not significant. No vulnerabilities were identified.

3.1.2.3.2 Floods

The DAEC design basis has been determined to meet the Standard Review Plan in effect in 1975. Based on this, the contribution to core damage frequency from external flood initiated accident sequences is judged to be less than 1E-06/yr. No vulnerabilities were identified.

3.1.2.3.3 Transportation and Nearby Facility Accidents

The hazards assessed in this facet of the IPEEE included:

- Transportation accidents
    - Aviation (commercial/general/military)
    - Marine (ship/barge)
    - Railroad
    - Truck
- Gas, oil or chemical pipeline accidents
- Nearby facility accidents
    - nearby industrial facilities
    - nearby military facilities
- On-site and offsite material storage accidents

Transportation hazards involving marine, railroad and truck accidents represent no significant risk to the plant based on separation distance. With respect to aviation hazards, two federal airways were identified to exist over the vicinity of the plant site. However, a detailed conservative analysis showed that traffic along these airways contributes less than 1E-06/yr to the plant core damage frequency. Therefore, transportation hazards do not pose a significant threat to plant safety.

With respect to pipeline hazards, this evaluation identified two natural gas pipelines within the five mile radius of the site. However, analysis showed that the pipelines are sufficiently small and distant (greater than 2 miles) so as to present no significant risk to the safe operation of the plant.

With respect to nearby facility hazards, no facility accident could be postulated that would impact the safe operation of the plant. The area around the site is rural. The small communities in the vicinity of the site have little or no heavy industry; the communities consist of small retail establishments. In addition, there are no nearby military facilities. Therefore, nearby facilities do not pose a significant threat to plant safety.

With respect to hazardous material storage, a 1980 survey performed to support a control room habitability study, concluded that onsite storage of gaseous chlorine represented the only significant hazardous material risk to the plant. Gaseous chlorine was eliminated in 1982 and replaced with sodium hypochlorite, which is non-hazardous. A 1994 survey showed that the hazardous material status in and around the plant had not changed significantly since the 1980 survey. Finally, a 2004 Control Room

Habitability study for toxic gases and smoke, completed in response to NRC Generic Letter 2003-001, did not identify any new hazards.

The hydrogen storage and distribution system was reviewed against the recommendations of Generic Letter 93-06, "Piping and the Use of Highly Combustible Gases in Vital Areas" (NRC 1993). The DAEC configuration was determined to meet the guidance provided in GL 93-06. Since the initial IPEEE, a 9000 gallon liquid hydrogen storage tank was added to the system. This tank was situated such that the distance from the tank to the nearest safety related structures complies with EPRI guidelines.

The auxiliary boiler pilot light propane storage tank (1T445) was identified as a potential risk outlier. The tank is located outside, 25 feet from the emergency diesel generator rooms. Evaluation of the tank shows that the tank does not present an immediate risk to plant safety, but a propane explosion can be postulated that could affect both diesel generators and offsite power. The largest contributor to the propane tank failure and subsequent explosion is due to human error (specifically vehicle impact). Concrete barriers have been placed around the propane tank to effectively eliminate the risk of vehicle impact, thereby assuring that the overall core damage frequency contribution is less than 1E-06/yr.

3.2 LEVEL 2 PRA MODEL

The Level 2 model used for the SAMA analysis was Revision 5C. As with the Level 1 PRA, plant modifications are screened for impact on the Level 2 PRA. If necessary, the model is upgraded to include the plant modification. This screening process identified no modifications which would affect the results of the SAMA study. Thus, no changes were made to the current Level 2 PRA model to accommodate the SAMA analysis.

3.2.1 Description of Level 2 PRA Model

The Level 2 is mainly phenomenon-based, and is driven by the results obtained in the Level 1 PRA along with certain post-accident mitigation strategies. The Level 2 accident sequences are designed with a detailed set of containment event trees (CETs). The DAEC Level 2 PRA uses an approach that was developed as part of the Nuclear Management and Resources Council (NUMARC) (now the Nuclear Energy Institute [NEI]) evaluation of containment performance (NUMARC 1991). This evaluation includes all systems, phenomena, and operator actions important to containment performance during severe accidents. This approach allows considerable detail to be reflected in the overall containment performance without losing the ability to depict the response in a containment event tree format.

The Level 1 accident sequences are grouped into core damage accident classes with similar characteristics and then are input into the CETs. Three different CET structures are used, depending upon the characteristics of the incoming Level 1 accident sequences. The CETs model the following key issues:

- Containment Isolation
- Core Melt Arrested In-Vessel
- Energetic Phenomena Post-Core Melt
- Steel Containment Shell Failure
- Containment Flooding
- Containment Heat Removal
- Containment Over-pressurization (or Over-temperature) Failure
- Suppression Pool Bypass
- Release Mitigation in Reactor Building

The containment event tree is analyzed through the linking of fault trees. Whenever possible, fault trees used in the Level 1 analysis are called into the CETs to avoid duplication of effort and to propagate dependencies. The accident sequence truncation limit used in quantification is 1E-12 in the Level 2.

The end state of the CETs is a radionuclide release to the environment. The release end states are categorized based on the magnitude and timing of the release (12 release categories are used). The results of revision 5C are presented below.

Table 3.2.1-1
Revision 5C Level 2 PRA Release Frequencies

Release Category	Release Frequency (per year)
Low-Low and Early (LL/E)	1.51E-07
Low-Low and Intermediate (LL/I)	1.52E-08
Low-Low and Late (LL/L)	1.45E-07
Low and Early (L/E)	7.67E-07
Low and Intermediate (L/I)	6.71E-07
Low and Late (L/L)	4.85E-07
Medium and Early (M/E)	4.27E-06
Medium and Intermediate (M/I)	1.09E-06
Medium and Late (M/L)	7.54E-08
High and Early (H/E)	1.39E-06
High and Intermediate (H/I)	2.37E-07
High and Late (H/L)	2.18E-07
Total Release:	9.52E-06

The total internal events release frequency for DAEC is calculated to be 9.52E-06 per year using the sequence model. The Level 2 release frequency does not match the Level 1 core damage frequency, because approximately 18% of the accident sequences modeled in the Level 1analysis result in no release (or a release within Technical Specification limits). These core damage accidents typically involve recovering coolant injection, arresting the core melt in-vessel, and maintaining the primary containment intact (i.e., no containment failure or bypass, and no EOP-directed RPV venting or containment venting).

The high and early release frequency (also known as the Large Early Release Frequency or LERF) is the most commonly used figure of merit in level 2 PRA analysis. This frequency is 1.39E-06 per year, or approximately 15 percent of the total release frequency. The top six initiating events based on the Fussell-Vesely importance measure are:

1. Loss of Offsite Power (31%)
2. Turbine Trip with Bypass (17%)
3. MSIV Closure (15%)
4. Inadvertent Open Relief Valve (9%)
5. Loss of Condenser Vacuum (6%)
6. Loss of Div 2 125 Volt DC Power (4%)

A review of basic event Fussell-Vesely values revealed that the top 10 systems are the same as those for Level 1. These are:

1. Normal AC Power
2. Emergency AC Power
3. CRD Hydraulic / RPS
4. 125 Volt DC Power
5. Standby Liquid Control
6. Reactor Core Isolation Cooling
7. River Water Supply
8. High Pressure Coolant Injection
9. Residual Heat Removal
10. RHR Service Water

Likewise, a review of basic event Fussell-Vesely values revealed that the top 10 operator actions are similar to those for Level 1. The top 10 risk significant operator actions for Level 2 are:

1. Operator Fails to Recover Torus Cooling
2. Operator Fails to Inject Standby Liquid Control Early (within 4 minutes)
3. Operator Fails to Bypass MSIV Isolation Interlocks During ATWS
4. Operator Fails to Recover the Main Condenser
5. Operator Fails to Vent Containment Per Emergency Operating Procedures
6. Operator Fails to Prevent Overfilling the Reactor Pressure Vessel
7. Operator Fails to Lower RPV Level to Top of Active Fuel for ATWS Level/Power Control
8. Operator Fails to Depressurize the RPV Given Depressurization Failed in Level 1
9. Operator Fails to Inhibit ADS During ATWS Events with High Pressure Injection Systems Available
10. Operator Fails to Recover Battery Charger

In the Level 3 modeling, it was assumed that the release was at ground level with zero heat release for all modeled sequences. Consideration of other release heights and release heat levels was treated in the sensitivity analyses discussed in Section 8.

3.2.2 Level 2 PRA Model Changes Since IPE Submittal

The changes to the Level 2 release frequencies for the twelve categories are presented below. Note that the total does not match the Level 1 CDF because events resulting in no release or releases below Technical Specifications were not included.

Table 3.2.2-1 Changes to Level 2 CDF by Release Category

Category	1992 Submittal	Rev 3A (3/95)	Rev 3B (8/95)	Rev 4A (3/98)	Rev 4B (12/01)	Rev 5A (10/03)	Rev 5B (2/05)	Rev 5C (7/07)
LL/E	1.78E-07	2.28E-07	1.66E-07	1.07E-07	1.12E-07	1.47E-07	1.50E-07	1.51E-07
LL/I	2.60E-09	1.52E-08	1.51E-08	1.40E-08	2.00E-08	1.51E-08	1.53E-08	1.52E-08
LL/L	3.26E-07	2.08E-07	1.73E-07	7.30E-08	9.48E-08	7.74E-08	8.04E-08	1.45E-07
L/E	1.37E-06	8.11E-07	8.04E-07	4.93E-07	4.95E-07	7.47E-07	7.55E-07	7.67E-07
L/I	2.27E-08	9.03E-08	5.32E-08	5.94E-08	4.07E-07	5.70E-07	5.79E-07	6.71E-07
L/L	8.62E-07	1.11E-06	9.84E-07	4.14E-07	5.36E-07	4.34E-07	4.51E-07	4.85E-07
M/E	1.61E-06	1.39E-05	4.24E-06	2.56E-06	3.81E-06	3.71E-06	3.88E-06	4.27E-06
M/I	4.51E-07	1.94E-06	1.92E-06	1.75E-06	1.92E-06	1.06E-06	1.08E-06	1.09E-06
M/L	2.20E-07	1.50E-07	1.25E-07	4.76E-08	7.50E-08	6.95E-08	7.25E-08	7.54E-08
H/E	5.02E-07	3.63E-06	1.32E-06	8.55E-07	1.14E-06	1.15E-06	1.23E-06	1.39E-06
H/I	1.07E-07	2.99E-07	2.98E-07	3.31E-07	3.74E-07	2.30E-07	2.34E-07	2.37E-07
H/L	5.00E-07	3.70E-07	3.27E-07	1.41E-07	1.99E-07	1.77E-07	1.88E-07	2.18E-07
Total Release	6.15E-06	2.28E-05	1.04E-05	6.85E-06	9.18E-06	8.39E-06	8.72E-06	9.52E-06

No changes to major modeling assumptions, containment event tree structure, accident progression / source term calculations, or binning of end states in the Level 2 PRA model have been made since the IPE submittal

3.3 MODEL REVIEW SUMMARY

DAEC was the first non-pilot plant to have a PSA Peer Certification (BWROG 1997). The PSA Certification process used a team of experienced PSA and system analysts to provide both an objective review of the PSA technical elements and a subjective assessment based on their PSA experience regarding the acceptability of the PSA elements.

The review team consisted of participants with significant expertise in both PSA development and PSA applications. The team was knowledgeable of PSA methodology and applications, nuclear plant design, and operational practices. The team utilized checklists to evaluate the scope, comprehensiveness, completeness, and fidelity of the DAEC PSA products available.

One of the key aspects of the review was the assessment of the PSA update and maintenance process. This process is a necessary part of a quality product to accurately reflect the many aspects of a changing plant and includes the following:

- Procedures
- Plant modifications
- Technical Specifications
- Operating Philosophy (e.g., on-line maintenance)
- Training

Facts and Observations considered by the certification team to be either extremely important or important are listed with their respective dispositions in Table 3.3-1.

The overall owner’s group peer review results can be summarized as follows: "…the DAEC PSA 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." (BWROG 1997)

Table 3.3-1 Disposition of Peer Review Facts & Observations

Sub-Element	Significance	Observation/Recommendation	Disposition
IE-14	B	ISLOCA may not be fully assessed with regard to RWCU. Evaluate the need for including RWCU in the PRA's ISLOCA study, and if necessary, develop a fault tree	Inclusion of RWCU in the PRA's ISLOCA was evaluated and rejected. RWCU was not included because its design pressure is the same as the primary system (re: IDF-25).
SY-8	B	Some non-dominant but potentially important common-cause failure modes have been ignored. Provide justification for not modeling certain nondominant common-cause events (documentation issue).	Justification for not modeling certain non-dominant common-cause events has been included in the documentation (re: IDF-31).
SY-9	B	Some support systems are "black-boxed" (i.e., Instrument air in Vent; RBCCW in CRD). Evaluate the need to develop fault trees for important "black-boxed" support systems (i.e., instrument air, RBCCW).	A fault tree for instrument air has been incorporated. CRD is not credited for alternate injection, therefore it is not included in the model (re: IDF-26).
SY-13	B	Air and nitrogen accumulators may not have been assessed for a 24 hour mission. Provide justification that components supported by air and nitrogen accumulators will remain operable for their required mission time.	Justification that components supported by air and nitrogen accumulators will remain operable for their required mission time has been completed (re: IDF-27).
DA-4	B	All component failure probability data are generic values; plant specific values are needed for certain elements. Incorporate plant specific component failure rate data into the PRA model.	Some plant specific component failure rate data has been incorporated into the PRA model (RE: IDF-22).
DA-4	B	A distinction should be made in MOV and AOV failure rates according to their test frequency	The need to differentiate between AOV and MOV failure probabilities was evaluated and determined to be unnecessary (re: IDF-28).
DA-10	B	Common cause failures of some groups of components, (e.g., circuit breakers) have not been included in the PSA model.	The adequacy of the use of common cause factors in the PRA mode was evaluated. Common cause factors for SRVs and EDG breakers were added (re: IDF-29).
HR-5&6	B	Pre-initiator human interactions have not been fully evaluated.	The adequacy of the use of pre-initiator Human Error Probabilities (HEPs) in the PRA model was evaluated. No model changes were made (re: IDF30).
HR-12	B	Justification is lacking for some low value human error probabilities. Particularly the 1E-06 value for LOPTORCOOLY (Operator Fails to Align Torus Cooling)	The 1E-06value was re-assessed and found to be appropriate (re: IDF-32).
HR-16	B	There is no clear evidence that HEP dependency effects have been evaluated.	Guidance was added to PSAG-2 stating that an HEP dependency review should be performed following an update to the PRA. Guidance was added to PTG-008 to describe how to perform an HEP dependency review

Table 3.3-1 Disposition of Peer Review Facts & Observations (Cont.)

Sub-Element	Significance	Observation/Recommendation	Disposition
HR-26	B	There is no clear evidence that HEP dependency effects have been evaluated.	Guidance was added to PSAG-2 stating that an HEP dependency review should be performed following an update to the PRA. Guidance was added to PTG-008 to describe how to perform an HEP dependency review
DE-6	A	Cutsets were not reviewed for multiple human actions.	A review of Human Error Probability (HEP) dependencies was performed for the Rev. 5 PRA model update as described in Section 3.3.1 of the Rev. 5 summary document.
QU-10	A	Guidance and examples of how human action dependencies are to be treated is lacking.	Guidance was added to PSAG-2 stating that an HEP dependency review should be performed following an update to the PRA. Guidance was added to PTG-008 to describe how to perform an HEP dependency review.
MU-6	B	Configuration control and physical security of the software and models is inadequate.	Department Instruction PSAG-1 has been updated to include guidance for maintenance, revision, and control of the PSA model and associated documents and software.
MU-9	B	Guidance for PSA updates does not include a requirement for an independent review of the results.	Department Instruction PSAG-1 has been updated to include guidance for review and approval of new or revised PSA elements. Section 4.2 pertains to review by a qualified internal reviewer while Section 4.3 pertains to review and validation by other organizations.
MU-11	B	The impact of new revisions on prior PRA applications does not appear to have been assessed.	Guidance for reassessment of prior applications is contained in Section 4.5 of PSAG-1. Review of affected PRA applications is described in Section 6.3 of the PRA Rev. 4 Summary Document.

Significance

- A Extremely important and necessary to address in order to assure the technical adequacy of the PRA or technical quality of the PRA or the qualify of the PRA update process. These are contingency items for certification.
- B Important and necessary to address, but may be deferred until the next PRA update. These are also contingency items for certification.

3.4 LEVEL 3 PRA MODEL

The MACCS2 code (NRC 1998) was used to perform the Level 3 PRA. The input parameters given with the MACCS2 “Sample Problem A,” which included the COMIDA2 food model, formed the basis for the present analysis. These generic values were supplemented with parameters specific to DAEC and the surrounding area. Site-specific data included population distribution, economic parameters, and agricultural production. Parameters describing the costs of evacuation, relocation and decontamination were escalated from the time of their formulation (1986) to present (July 2007) costs. Plant-specific release data included the time-activity distribution of nuclide releases and release frequencies. The behavior of the population during a release (evacuation parameters) was based on plant and site-specific set points (i.e., declaration of a General Emergency) and evacuation time estimates (TOMCOD 2003). These data were used in combination with site specific meteorology to simulate the probability distribution of impact risks (exposure and economic) to the surrounding (within 50 miles) population from the 12 evaluated source term category releases at DAEC.

3.4.1 Population Distribution

The population distribution was based on the 2000 census as accessed by SECPOP2000 (NRC 2003). The baseline population was determined for each of the sixteen directions and each of ten concentric distance rings with outer radii at 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 miles surrounding the site. The transient population within ten miles of the site was included. County growth rates, based on projections from the State Data Center of Iowa (State Library 2006), were applied to estimate the population distribution at the year 2040.

3.4.2 Economic Data

MACCS2 requires the spatial distribution of certain agriculture and economic data (fraction of land devoted to farming, annual farm sales, fraction of farm sales resulting from dairy production, and property value of farm and non-farm land) in the same manner as the population. This was again done by applying the SECPOP2000 program, changing the regional economic data format to comply with MACCS2 input requirements. In this case, SECPOP2000 was used to access data from the 1997 National Census of Agriculture; the version 3.12.01 data file accessed by SECPOP2000 for that information, COUNTY97.DAT, was revised by filling its “notes” parameter so that data from the proper county is associated with the site. The program’s specification of crop production parameters for the 50-mile region (e.g., fraction of farmland devoted to grains, vegetables, etc.) was also applied.

Area-wide farm wealth was calculated from the 2002 National Census of Agriculture county statistics (USDA 2002) for farm land, building and machinery. Only the fraction of each county within 50 miles of DAEC was considered. The area-wide non-farm wealth was taken as the population-weighted average of the SECPOP2000 non-farm land property value.

In addition, generic economic data that is 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 that input was first specified. A factor of 1.90, representing cost escalation from 1986 to July 2007 was applied to parameters describing cost of evacuating and relocating people, land decontamination, and property condemnation.

3.4.3 Nuclide Release

The core inventory corresponds to the end-of-cycle values for DAEC operating at 1912 MWt. Table 3.4.3-1 gives the estimated DAEC core inventory.

Release frequencies, nuclide release fractions (of the core inventory), shown in Table 3.4.3-2, and the time distribution of the release (described in Table 3.4.3-2 for noble gases and Cs) were analyzed to determine the sum of the exposure (50-mile dose) and economic (50-mile economic costs) risks from accident sequences representing 12 source term categories (also given in Table 3.4.3-2). Each accident frequency was chosen to represent the set of similar accident releases. DAEC nuclide release categories, as determined by the MAAP computer code, were related to the MACCS categories as shown in Table 3.4.3-3. Release duration periods were defined which represented the time distribution of each category's releases. Release inventories of each of the two chemical forms of the Cs and Te releases, as given by the MAAP code output, were incorporated into the nuclide release fractions.

Table 3.4.3-1 Estimated DAEC Core Inventory

Nuclide	Core Inventory (Curies)		Nuclide	Core Inventory (Curies)
Co-58	2.92E+05		Te-131m	7.62E+06
Co-60	3.50E+05		Te-132	7.37E+07
Kr-85	7.94E+05		I-131	5.20E+07
Kr-85m	1.28E+07		I-132	7.50E+07
Kr-87	2.44E+07		I-133	1.05E+08
Kr-88	3.43E+07		I-134	1.15E+08
Rb-86	1.49E+05		I-135	9.85E+07
Sr-89	4.60E+07		Xe-133	1.01E+08
Sr-90	6.37E+06		Xe-135	3.65E+07
Sr-91	5.83E+07		Cs-134	1.55E+07
Sr-92	6.37E+07		Cs-136	4.67E+06
Y-90	6.58E+06		Cs-137	8.88E+06
Y-91	5.99E+07		Ba-139	9.32E+07
Y-92	6.40E+07		Ba-140	8.99E+07
Y-93	7.49E+07		La-140	9.67E+07
Zr-95	8.48E+07		La-141	8.48E+07
Zr-97	8.59E+07		La-142	8.17E+07
Nb-95	8.52E+07		Ce-141	8.53E+07
Mo-99	9.83E+07		Ce-143	7.81E+07
Tc-99m	8.61E+07		Ce-144	7.08E+07
Ru-103	8.30E+07		Pr-143	7.55E+07
Ru-105	5.88E+07		Nd-147	3.44E+07
Ru-106	3.50E+07		Np-239	1.11E+09
Rh-105	5.53E+07		Pu-238	3.23E+05
Sb-127	5.83E+06		Pu-239	2.62E+04
Sb-129	1.72E+07		Pu-240	3.85E+04
Te-127	5.80E+06		Pu-241	1.10E+07
Te-127m	7.84E+05		Am-241	1.54E+04
Te-129	1.69E+07		Cm-242	3.89E+06
Te-129m	2.51E+06		Cm-244	2.93E+05

Source: Supplied by DAEC as curies/MWt. Multiplied by 1912 MWt to account for 2007 plant upgrade

Table 3.4.3-2. Accident Sequence Frequencies

Source Term Category	**H/L**	**H/I**	**H/E**	**M/L**	**M/I**	**M/E**
Representative Sequence	2T02	3A01A	4A01LD	2L01	3A02	1D03
Frequency	2.18E-07	2.37E-07	1.39E-06	7.54E-08	1.09E-06	4.27E-06
Release Fraction by Release Category						
Xe/Kr	1.00E+00	7.33E-01	1.00E+00	8.66E-01	8.66E-01	1.00E+00
I	1.72E-01	3.43E-01	1.57E-01	4.05E-01	1.72E-01	7.45E-02
Cs	1.64E-01	5.20E-01	2.37E-01	4.18E-01	1.69E-01	9.65E-02
Te	1.84E-01	1.56E-01	1.77E-01	2.06E-01	0.00E+00	5.59E-06
Sr	6.43E-03	1.81E-06	9.20E-03	6.44E-03	8.32E-05	3.98E-07
Ru	2.39E-03	2.27E-07	6.14E-04	5.07E-02	9.58E-03	2.60E-09
La	4.38E-04	1.01E-07	6.53E-04	4.29E-04	9.72E-07	1.23E-09
Ce	2.48E-03	7.51E-07	3.39E-03	2.23E-03	2.36E-06	1.10E-08
Ba	3.20E-03	1.15E-06	4.34E-03	1.16E-02	3.49E-04	1.94E-07
Sb	1.75E-02	1.57E-02	2.07E-01	2.86E-01	5.03E-03	5.12E-04
Release time (hr from scram) of noble gas/Cs release	40-60/ 40-100	18-30/ 18-40	3.3-10/ 3.3-48	28.9-30/ 28.9-60	10-30/ 10-40	1.9-10/ 1.9-60
Source Term Category	L/L	L/I	L/E	LL/L	LL/I	LL/E
Representative Sequence	2T01WW	1A03A	1D11	3A01B	1A03LW	1D12
Frequency	4.85E-07	6.71E-07	7.67E-07	1.45E-07	1.52E-08	1.51E-07
Release Fraction by Release Category						
Xe/Kr	1.00E+00	1.00E+00	7.36E-01	6.26E-01	1.00E+00	7.39E-01
I	8.46E-03	1.26E-02	1.84E-04	5.55E-04	5.31E-03	1.72E-05
Cs	9.32E-03	1.07E-02	2.10E-04	2.28E-04	4.91E-03	2.00E-05
Te	4.00E-03	9.77E-03	3.35E-08	0.00E+00	9.47E-03	1.71E-08
Sr	1.13E-04	7.85E-07	3.44E-09	2.88E-08	3.30E-04	1.67E-09
Ru	2.58E-04	9.45E-10	1.61E-10	1.93E-05	1.75E-07	5.32E-12
La	6.58E-06	6.08E-08	3.31E-11	2.80E-10	2.25E-05	1.65E-11
Ce	4.08E-05	3.70E-07	2.17E-10	1.44E-09	1.20E-04	1.04E-10
Ba	8.47E-05	1.12E-06	1.62E-09	2.65E-07	1.38E-04	7.56E-10
Sb	3.10E-03	4.35E-03	2.14E-07	3.66E-07	3.94E-03	1.34E-08
Release time (hr from scram) of noble gas/Cs release	40-80/ 40-80	16-20/ 16-60	1.9-20/ 1.9-10	35.7-40/ 35.7/40	19.5-20/ 19.5-50	1.9-20/ 1.9-10

Table 3.4.3-3. MACCS release categories vs. DAEC MAAP release categories.

MACCS Release Categories	DAEC MAAP Release Categories
Xe/Kr	1 – noble gases
I	2 – CsI
Cs	2 & 6 – CsI and CsOH
Te	3 & 11- TeO_2 & Te_2
Sr	4 – SrO
Ru	5 – MoO_2 (Mo is in Ru MACCS category)
La	8 – La_2O_3
Ce	9 – CeO_2 & UO_2
Ba	7 – BaO
Sb (supplemental category)	10 – Sb

Alternative representative sequences were considered for some of the source term categories, e.g., 3C01 for the H/E category. In each of these cases, the sequence yielding the greatest conditional population-dose was chosen. In all such cases, impacts were comparable between the chosen and alternative sequence.

The reactor building width and height above grade are each 140 feet (FPL 2005). 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 (ERIN 1995b). It is expected that reactor building releases would be from the blowout vents approximately 100 feet above grade (Erin 1995c). The reactor building release height was a parameter considered in sensitivity analyses, presented in Section 8.4. The thermal content of each of the releases was assumed to be the same as ambient, i.e., buoyant plume rise was not modeled. This assumption was also considered in the sensitivity analyses.

3.4.4 Emergency Response

Reactor trip for each sequence was taken as time zero relative to the core containment response times. A General Emergency is declared when plant conditions degrade to the point where it is judged that there is a credible risk to the public; it was assumed here that the declaration would coincide with the onset of core damage (ERIN 1995b). The times used in the analysis for the different source term categories are shown in Table 3.4.4-1. It is expected that a general emergency will be declared significantly prior to core damage for some sequences, e.g., Class 2 and 4 (ERIN 1995d). A time zero general emergency declaration was considered in sensitivity analyses, presented in Section 8.4.

Table 3.4.4-1 General Emergency Declaration Times (hours from reactor trip)

Source Term Category	H/L	H/I	H/E	M/L	M/I	M/E	L/L	L/I	L/E	LL/L	LL/I	LL/E
G.E. Time	39.1	0.4	1.6	26.5	0.4	1.4	38.5	1.3	1.4	0.4	1.3	1.4

The MACCS2 User's Guide input parameters of 95 percent of the population within 10 miles of the plant (Emergency Planning Zone, EPZ) evacuating and 5 percent not evacuating were employed. These values are conservative relative to the NUREG-1150 study, which assumed evacuation of 99.5 percent of the population within the Emergency Planning Zone (NRC 1998).

The evacuees are assumed to begin evacuation 17 minutes (NRC 1998) after a general emergency has been declared at an evacuation radial speed of 0.314 m/sec. This speed is derived from the projected time to evacuate the entire EPZ under winter weekday, mid-day adverse weather conditions during the year 2000, the census year of the evacuation study. The evacuation speed was projected to year 2040 conditions by conservatively assuming that all of the roads in 2000 transported traffic at their maximum throughput and that no new roads would be constructed (although the roads would be maintained at 2000 conditions). The 2040 evacuation speed was then the 2000 speed multiplied by the ratio of 2000 to projected 2040 EPZ (10-mile) populations. That estimated 2040 evacuation speed, 0.205 m/sec, was used in the risk analysis. The evacuation speed was considered further in the sensitivity analyses presented in Section 8.4.

3.4.5 Meteorological Data

Sequential hourly onsite meteorology data from 2002 through 2006 were used in MACCS2. Of the 2002-2006 hourly data points of interest (10-meter wind speed; 10-meter wind direction; stability class and precipitation), 0.13; 0.15; 0.17; 0.63; and 0.09% respectively were missing. Data gaps were filled in by (in order of preference): using corresponding data from another level (taking the relationship between the levels as determined from immediately preceding hours), interpolation (if the data gap was less than 4 hours), or using data from the same hour and a nearby day of a previous year.

The 2005 data set was found to result (see subsequent discussion of sensitivity analysis) in the largest dose and economic cost risks and was used to create the one-year sequential hourly data set used in the baseline MACCS2 runs. Atmospheric mixing heights were specified for AM and PM hours for each season of the year. These values ranged from 300 meters for Summer AM to 1500 meters for Summer PM (EPA 1972).

3.5 SEVERE ACCIDENT RISK RESULTS

The resulting annual risk from the analyzed DAEC releases is provided in Table 3.5-1.

Table 3.5-1 Results of DAEC Level 3 PRA Analysis (Annual Risk, Internal Events only)

Source Term Category	H/L	H/I	H/E	M/L	M/I	M/E	
Population dose risk (person-							
0-50 miles	0.619	0.822	4.59	0.421	2.70	9.48	
Total economic cost risk ($)							
0-50 miles	2,530	3,980	16,400	1,030	12,200	38,200	

Source Term Category	L/L	L/I	L/E	LL/L	LL/I	LL/E	Total
Population dose risk							
0-50 miles	0.426	0.643	0.0487	0.00893	0.0100	0.00156	19.8
Total economic cost risk ($)							
0-50 miles	902	1,400	47.6	10.9	19.0	0.26	76,700

Approximately 50% of the total baseline risk (both dose and cost) is from release category M/E, owing to its relatively large conditional dose and cost impacts coupled with its frequency, which is almost equal to that of the other categories combined. The total DAEC risk was found to be due chiefly to its Cs release.

The annual baseline population dose risk within 50 miles of DAEC is calculated to be 19.8 person-rem. The total annual economic risk was calculated at $76,700.

4 COST OF SEVERE ACCIDENT RISK / MAXIMUM BENEFIT

Cost/benefit evaluation of SAMAs is based upon the cost of implementation of a SAMA compared to the averted onsite and offsite costs resulting from the implementation of that SAMA. The methodology used for this evaluation was based upon the NRC's guidance for the performance of cost-benefit analyses found in NUREG/BR-0184 (NRC 1997). This 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 (worth) of averted public exposure ($)
AOC = present value (worth) of averted offsite property damage costs ($)
AOE = present value (worth) of averted occupational exposure ($)
AOSC = present value (worth) of averted onsite costs ($)
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 is not considered beneficial. The derivation of each of these costs is described in below.

The following specific values were used for various terms in the analyses:

Present Worth

The present worth was determined by:

$$PW = \frac{1 - e^{-rt}}{r}$$

Where:

r is the discount rate = 7% (assumed throughout these analyses)
t is the duration of the license renewal = 20 years
PW is the present worth of a string of annual payments = 10.76

Dollars per REM

The conversion factor used for assigning a monetary value to on-site and off-site exposures was $2,000/person-rem averted. This is consistent with the NRC's regulatory analysis guidelines presented in and used throughout NUREG/BR-0184, (NRC 1997).

On-site Person REM per Accident

The occupational exposure associated with severe accidents was assumed to be 23,300 person-rem/accident. This value includes a short-term component of 3,300 person-rem/accident and a long-term component of 20,000 person-rem/accident. These estimates are consistent with the "best estimate" values presented in Section 5.7.3 of NUREG/BR-0184 (NRC 1997). In the cost/benefit analyses, the accident-related on-site exposures were calculated using the best estimate exposure components applied over the on-site cleanup period.

On-site Cleanup Period

In the cost/benefit analyses, the accident-related on-site exposures were calculated over a 10-year cleanup period.

Present Worth On-site Cleanup Cost per Accident

The estimated cleanup cost for severe accidents was assumed to be $1.5E+09/accident (undiscounted). This value was derived by the NRC in NUREG/BR-0184, Section 5.7.6.1, Cleanup and Decontamination (NRC 1997). This cost is the sum of equal annual costs over a 10-year cleanup period. At a 7% discount rate, the present value of this stream of costs is $1.1E+09.

4.1 OFF-SITE EXPOSURE COST

Accident-Related Off-Site Dose Costs

Offsite doses were determined using the MACCS2 model developed for DAEC. Costs associated with these doses were calculated using the following equation:

$$APE = \left(F_S D_{P_S} - F_A D_{P_A}\right) R \frac{1 - e^{-rt_f}}{r} \qquad (1)$$

where:

APE = monetary value of accident risk avoided due to population doses, after discounting

R = monetary equivalent of unit dose, ($/person-rem)

F = accident frequency (events/yr)

D_P = population dose factor (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = real discount rate

t_f = years remaining until end of facility life

The values used are:

R = $2000/person-rem

r = 0.07

D_P = 23,300 person-rem/accident (best estimate)

$$APE = (\$2.15E + 4)\left(F_S D_{P_S} - F_A D_{P_A}\right)$$

4.2 OFF-SITE ECONOMIC COST

Accident-Related Off-Site Property Damage Costs

$$AOC = \left(F_S P_{D_S} - F_A P_{D_A}\right) \frac{1 - e^{-rt_f}}{r}$$

AOC = monetary value of accident risk avoided due to offsite property damage, after discounting

P_D = offsite property loss factor (dollars/event)

4.3 ON-SITE EXPOSURE COST

Methods for Calculating Averted Costs Associated with Onsite Accident Dose Costs

a) **Immediate Doses** (at time of accident and for immediate management of emergency)

For the case where the plant is in operation, the equations in NUREG/BR-0184 (NRC 1997).can be expressed as:

$$W_{IO} = \left(F_S D_{IO_S} - F_A D_{IO_A}\right) R \frac{1 - e^{-rt_f}}{r} \qquad (1)$$

where:

- W_{IO} = monetary value of accident risk avoided due to immediate doses, after discounting,
- R = monetary equivalent of unit dose, ($/person-rem),
- F = accident frequency (events/yr),
- D_{IO} = immediate occupational dose (person-rem/event),
- S = status quo (current conditions),
- A = after implementation of proposed action,
- r = real discount rate,
- t_f = years remaining until end of facility life.

The values used are:

- R = $2000/person rem
- r = .07
- D_{IO} = 3,300 person-rem /accident (best estimate)

The license extension time of 20 years is used for $t_{f.}$

For the basis discount rate, assuming F_A is zero, the <u>best estimate</u> of the limiting savings is

$$\begin{aligned} W_{IO} &= \left(F_S D_{IO_S}\right) R \frac{1 - e^{-rt_f}}{r} \\ &= 3300 * F_S * \$2000 * \frac{1 - e^{-.07*20}}{.07} \\ &= F_S * \$6{,}600{,}000 * 10.763 \\ &= F_S * \$0.71E+8 , \end{aligned}$$

b) **Long-Term Doses** (process of cleanup and refurbishment or decontamination)

For the case where the plant is in operation, the equations can be expressed as:

$$W_{LTO} = \left(F_S D_{LTO_S} - F_A D_{LTO_A}\right) R * \frac{1 - e^{-rt_f}}{r} * \frac{1 - e^{-rm}}{rm} \qquad (2)$$

where:

W_{LTO} = monetary value of accident risk avoided long term doses, after discounting, $

m = years over which long-term doses accrue. (NRC 1997)

The values used are:

R = $2000/person rem

r = .07

D_{LTO} = 20,000 person-rem /accident (best estimate)

m = “as long as 10 years”

The license extension period of 20 years is used for $t_{f.}$

For the discount rate of 7%, assuming F_A is zero, the <u>best estimate</u> of the limiting savings is

$$\begin{aligned} W_{LTO} &= \left(F_S D_{LTO_S}\right) R * \frac{1 - e^{-rt_f}}{r} * \frac{1 - e^{-rm}}{rm} \\ &= \left(F_S\, 20000\right) \$2000 * \frac{1 - e^{-.07*20}}{.07} * \frac{1 - e^{-.07*10}}{.07*10} \\ &= F_S * \$40{,}000{,}000 * 10.763 * 0.719 \\ &= F_S * \$3.10E + 8\ ,. \end{aligned}$$

c) **<u>Total Accident-Related Occupational (On-site) Exposures</u>**

Combining equations (1) and (2) above, using delta (Δ) to signify the difference in accident frequency resulting from the proposed actions, and using the above numerical values, the long term accident related on-site (occupational) exposure avoided (AOE) is:

<u>Best Estimate</u>:

$$AOE = \Delta W_{IO} + \Delta W_{LTO} = \Delta F * \$\left(0.71 + 3.1\right) E + 8 = \Delta F * \$3.81E + 8$$

4.4 ON-SITE ECONOMIC COST

Methods for Calculation of Averted Costs Associated with Accident-Related On-Site Property Damage

a) **Cleanup/Decontamination**

A total cleanup/decontamination cost of $1.5E+09 was used as a reasonable estimate (NUMARC 1991). Considering a 10-year cleanup period, the present value of this cost is:

$$PV_{CD} = \left(\frac{C_{CD}}{m}\right)\left(\frac{1-e^{-rm}}{r}\right)$$

Where
PV_{CD} = Present value of the cost of annual cleanup/decontamination,
C_{CD} = Total cost of the cleanup/decontamination effort,
m = Cleanup period,
r = Discount rate.

Based upon the values previously assumed:

$$PV_{CD} = \left(\frac{\$1.5E+9}{10}\right)\left(\frac{1-e^{-.07*10}}{.07}\right)$$
$$PV_{CD} = \$1.079E+09$$

This cost is integrated over the term of the proposed license extension as follows:

$$U_{CD} = PV_{CD}\,\frac{1-e^{-rt_f}}{r}$$

Where
U_{CD} = Net present value of cleanup and decontamination over the life of the facility (in dollars per year).
Based upon the values previously assumed:

$$U_{CD} = \$1.079E+9\ [10.763]$$
$$U_{CD} = \$1.161E+10$$

b) **Replacement Power Costs**

Replacement power costs, U_{RP}, are an additional contributor to onsite costs. These are calculated in accordance with NUREG/BR-0184, Section 5.6.7.2.[1] Since replacement power will be needed for that time period following a severe accident, for the remainder of the expected generating plant life, long-term power replacement calculations have been used. The calculations are based on the 910 MWe reference plant, and are conservatively scaled down for the 610 MWe net Duane Arnold plant. The present value of replacement power is calculated as follows:

$$PV_{RP} = \left(\frac{(\$1.2E+8)\frac{(Ratepwr)}{(910MWe)}}{r} \right) \left(1 - e^{-rt_f}\right)^2$$

Where

PV_{RP} = Present value of the cost of replacement power for a single event,

t_f = years remaining until end of facility life,

r = Discount rate,

Ratepwr = Rated power of the unit (including the planned power uprate).

The $1.2E+08 value has no intrinsic meaning but is a substitute for a string of non-constant replacement power costs that occur over the lifetime of a “generic” reactor after an event (NRC 1997). This equation was developed per NUREG/BR-0184 for discount rates between 5% and 10% only.

For discount rates between 1% and 5%, NUREG/BR-0184 indicates that a linear interpolation is appropriate between present values of $1.2E+09 at 5% and $1.6E+09 at 1%. So for discount rates in this range the following equation was used to perform this linear interpolation.

$$PV_{RP} = \left\{ (\$1.6E+9) - \left(\frac{[(\$1.6E+9) - (\$1.2E+9)]}{[5\% - 1\%]} * [r_s - 1\%] \right) \right\} * \left\{ \frac{Ratepwr}{910MWe} \right\}$$

Where

r_s = Discount rate (small), between 1% and 5%.

Ratepwr = Rated power of the unit (including the planned power uprate)

[1] The section number for Section 5.6.7.2 apparently contains a typographical error. This section is a subsection of 5.7.6 and follows 5.7.6.1. However, the section number as it appears in the NUREG will be used in this document.

To account for the entire lifetime of the facility, U_{RP} was then calculated from PV_{RP}, as follows:

$$U_{RP} = \frac{PV_{RP}}{r}\left(1 - e^{-rt_f}\right)^2$$

Where
U_{RP} = Present value of the cost of replacement power over the life of the facility.

Again, this equation is only applicable in the range of discount rates from 5% to 10%. NUREG/BR-0184 states that for lower discount rates, linear interpolations for U_{RP} are recommended between \$1.9E+10 at 1% and \$1.2E+10 at 5%. The following equation was used to perform this linear interpolation:

$$U_{RP} = \left\{\left(\$1.9E+10\right) - \left(\frac{\left[\left(\$1.9E+10\right) - \left(\$1.2E+10\right)\right]}{\left[5\% - 1\%\right]} * \left[r_s - 1\%\right]\right)\right\} * \left\{\frac{Ratepwr}{910MWe}\right\}$$

Where
r_s = Discount rate (small), between 1% and 5%.
Ratepwr = Rated power of the unit (including the planned power uprate)

c) **Repair and Refurbishment**

It is assumed that the plant would not be repaired/refurbished; therefore, there is no contribution to averted onsite costs from this source.

d) **Total Onsite Property Damage Costs**

The net present value of averted onsite damage costs is, therefore:

$$AOSC = F * \left(U_{CD} + U_{RP}\right)$$

Where F = Annual frequency of the event.

4.5 TOTAL COST OF SEVERE ACCIDENT RISK / MAXIMUM BENEFIT

Cost/benefit evaluation of the maximum benefit (or maximum attainable benefit, MAB) is baseline risk of the plant converted dollars by summing the contributors to cost.

Maximum Benefit Value = (APE + AOC + AOE + AOSC)
where APE = present value of averted public exposure (\$),
AOC = present value of averted offsite property damage costs (\$),
AOE = present value of averted occupational exposure (\$),

AOSC = present value of averted onsite costs ($).

For Duane Arnold, this value is $2,261,022 as shown below.

Parameter	Present Dollar Value ($)
Averted Public Exposure	$666,236
Averted offsite costs	$1,292,225
Averted occupational exposure	$6,534
Averted onsite costs	$296,027
Total	$2,261,022

5 SAMA IDENTIFICATION

A list of SAMA candidates was developed by reviewing the major contributors to CDF and population dose based on the plant-specific risk assessment and the standard BWR list of enhancements (NEI 2005). This section discusses the SAMA selection process and its results.

5.1 PRA IMPORTANCE

Risk reduction worth (RRW) for the basic events in the baseline model was used to identify those basic events that could have a significant potential for reducing risk. All the basic events having a risk reduction worth of 1.005 or greater were considered as potential SAMAs. This group of basic events is shown on Table 3.1.1.1-1 ranked by their importances (RRW). These basic events were further divided into human action basic events and hardware basic events, Tables 5.1-1 and 5.1-2 respectively.

The current plant procedures and training meet current industry standards. There are no additional specific procedure improvements that could be identified that would affect the result of the HEP calculations. Therefore, no SAMA items were added to the plant specific list of SAMAs as a result of the human actions on the list of basic events with RRW greater than 1.005. Those human actions shown on Table 5.1-1 are, therefore, not identified as potential SAMA candidates.

The hardware basic events found to dominate the risk reduction potential are shown in Table 5.1-2. Each of these events was considered for treatment in the SAMA analysis. Table 5.1-2 identifies the SAMA candidate number(s) associated with each of the basic events.

Table 5.1-1 List of Dominant Human Action Contributors

Basic Event	RRW	Description
B-OPSLCE---U	1.0993	Operator Fails to Inject SBLC Early (Within 4 Minutes)
FTPE-Q4--Q4-	1.0591	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)
V-OPTORVENTU	1.0529	Operator Fails to Vent Containment Per EOPs
FTPE-L---L--	1.0527	Operator Fails to Prevent Overfilling RPV
L2OPNOREC--U	1.0489	Operator Fails to Recover Torus Cooling
FTPE-L1--L1-	1.0416	Operator Fails to Lower RPV Level to TAF for ATWS Pwr Cntrl
FTPE-X---X--	1.0310	Operator Fails to Inhibit ADS (ATWS with High Press Inj)
FTPE-L2--L2-	1.0298	Operator Fails to Restore RPV Level Post ED (ATWS)
C-OPNOREP--U	1.0290	Operator Fails to Recover Main Condenser
O-OPMANDEP-U	1.0233	Operator Fails to Manually Initiate ADS (Non-Med LOCA)
FTPE-LA--LA-	1.0228	Operator Fails to Prevent Overfilling RPV
FTPE-TR--TR-	1.0180	Operator Fails to Bypass HPCI/RCIC Low RPV Press Trip
L-OPCHRTRNSY	1.0174	Operator Fails to Follow EOPs for Cont. Ht. Removal
V-OPVENTTRNY	1.0173	Operator Fails to Vent Torus (Transients/LOCA)
C-OPCD03---U	1.0168	Operator Fails to Open an MSIV and/or Bypass Valve
B-OPSLCLAT3U	1.0164	Operator Fails to Inject SBLC Early (Within 14 Minutes)
FTPE-Q3--Q3-	1.0144	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)
W-OPWS04---U	1.0130	Operator Fails to Open CV4914
C-OPALTINJ-U	1.0130	Operator Fails to Initiate Condensate for Alt Inj
W-OPWS02---U	1.0124	Operator Fails to Open CV4915
FTPE-XA--XA-	1.0116	Operator Fails to Inhibit ADS (ATWS with No High Press Inj)
I-OPLRESPERX	1.0111	Miscalibration of Low Press Permiss Instrumentation
H-OP14-----U	1.0107	Operator Fails to Shutoff HPCI or RCIC
Q-OPLEVEL-TT	1.0094	Operator Fails to Cntrl Rx Level Following Scram
Z-OPWELLWTRU	1.0091	Operator Fails to Maximize Well Water to Circ Pit
FTPE-X1--X1-	1.0084	Operator Fails to Manually Depressurize RPV (ATWS)
L-OPCHRATWSY	1.0083	Operator Fails to Follow EOPs for Cont. Ht. Removal
Q-OPFW99--LU	1.0080	Operator Fails to Initiate Feedwater (Large LOCA/ATWS)
P-OPBCREC--Y	1.0070	Operator Fails to Recover Battery Charger
O-OPMNDPML-U	1.0064	Operator Fails to Manually Initiate ADS (Medium LOCA)
U-OP2NOREPRS	1.0061	Operator Fails to Repressurize RPV for HPCI
W-OPFFWS04--	1.0054	Operator Fails to Open CV4910A
W-OPFFWS03--	1.0054	Operator Fails to Open CV4910B
G-OPLOCSTRTU	1.0053	Operator Fails to Close Breaker to Start GSW Pump

Table 5.1-2 List of Dominant Hardware Contributors

Basic Event	RRW	Description	SAMA Analysis Treatment
PDI1947	1.0529	This represents failure of the RHRSW Loop 'B' HX Diff Press Indicator	See SAMA 165
E/P4914	1.0330	Control Air Supply E/P converter for CV4914	See SAMA 163
CB8490	1.0328	This term represents failure of Switchyard Control Breaker "M".	SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
1G031	1.0286	This represents failure of the Div 1 Standby Diesel Generator.	SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
E/P4915	1.0284	Control Air Supply E/P converter for CV4915	See SAMA 163
1G021	1.0283	This represents failure of the Div 2 Standby Diesel Generator.	SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard.
1P216	1.0250	This represents failure of the HPCI Pump/Turbine.	SAMAs 27, 28, 29, 31, 33, 34 evaluate improvements that would reduce the risk of high pressure injection failures.
PS4529	1.0156	RPV Low Pressure Permissive for LPCI/CS	See SAMA 166
PS4545	1.0156	RPV Low Pressure Permissive for LPCI/CS	See SAMA 166
1A311	1.0134	This represents failure of the SBDG 1G031 to Bus 1A3 Circuit Breaker.	SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard. SAMA 23 evaluates the risk due to breaker failures.
1A411	1.0132	This represents failure of the SBDG 1G021 to Bus 1A4 Circuit Breaker.	SAMAs 11, 14, 15, 17, 20, 24, and 26 evaluate improvements in the AC power system that would reduce the risk of loss of power to/from the switchyard. SAMA 23 evaluates the risk due to breaker failures.
1T218	1.0106	This represents failure of the SBLC Storage Tank.	SAMAs 118, 119 evaluate alternate means of boron injection in ATWS.
1P226	1.0104	This represents failure of the RCIC Turbine/Pump.	SAMAs 27, 28, 29, 31, 33, 34 evaluate improvements that would reduce the risk of high pressure injection failures.
PS4530	1.0101	RPV Low Pressure Permissive for LPCI/CS	See SAMA 166
PS4548	1.0101	RPV Low Pressure Permissive for LPCI/CS	See SAMA 166
HS4914	1.0051	This represents failure of the RWS Loop 'B' Makeup Hand Switch	See SAMA 164
PDI2046	1.0050	This represents failure of the RHRSW Loop 'A' HX Diff Press Indicator	See SAMA 165

5.2 PLANT IPE

The Duane Arnold IPE was examined to determine whether any additional plant specific improvements were identified. Several potential enhancements were identified and these are included in the SAMA list discussed in Section 5.5.

5.3 PLANT IPEEE

The Duane Arnold IPEEE was examined to determine whether any additional plant specific improvements were identified. Several potential enhancements were identified and these are included in the SAMA list discussed in Section 5.5.

5.4 INDUSTRY SAMA CANDIDATES

The generic BWR enhancement list from Table 13 of NEI 2005 was included in the list of Phase I SAMA candidates to assure adequate consideration of potential enhancements identified by other industry studies.

5.5 LIST OF PHASE I SAMA CANDIDATES

Table 5.5-1 provides the combined list of potential SAMA candidates considered in the DAEC SAMA analysis. From this table it can be seen that 166 SAMA candidates were identified for consideration.

Table 5.5-1 List of SAMA Candidates

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO.	AC/DC	BWR SAMA Candidates (NEI 1995)
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	AC/DC	BWR SAMA Candidates (NEI 1995)
3	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.	Improved availability of DC power system.	AC/DC	BWR SAMA Candidates (NEI 1995)
4	Improve DC bus load shedding.	Extended DC power availability during an SBO.	AC/DC	BWR SAMA Candidates (NEI 1995)
5	Provide DC bus cross-ties.	Improved availability of DC power system.	AC/DC	BWR SAMA Candidates (NEI 1995)
6	Provide additional DC power to the 120/240V vital AC system.	Increased availability of the 120 V vital AC bus.	AC/DC	BWR SAMA Candidates (NEI 1995)
7	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.	Increased availability of the 120 V vital AC bus.	AC/DC	BWR SAMA Candidates (NEI 1995)
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	Improved chances of successful response to loss of two 120V AC buses.	AC/DC	BWR SAMA Candidates (NEI 1995)
9	Reduce DC dependence between high-pressure injection system and ADS.	Improved containment depressurization and high-pressure injection following DC failure.	AC/DC	BWR SAMA Candidates (NEI 1995)
10	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)
11	Revise procedure to allow bypass of diesel generator trips.	Extended diesel generator operation.	AC/DC	BWR SAMA Candidates (NEI 1995)
12	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
13	Create AC power cross-tie capability with other unit (multi-unit site).	Increased availability of on-site AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)
14	Install an additional, buried off-site power source.	Reduced probability of loss of off-site power.	AC/DC	BWR SAMA Candidates (NEI 1995)
15	Install a gas turbine generator.	Increased availability of on-site AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)
16	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)
17	Install a steam-driven turbine generator that uses reactor steam and exhausts to the suppression pool.	Increased availability of on-site AC power.	AC/DC	BWR SAMA Candidates (NEI 1995)
18	Improve uninterruptible power supplies.	Increased availability of power supplies supporting front-line equipment.	AC/DC	BWR SAMA Candidates (NEI 1995)
19	Create a cross-tie for diesel fuel oil (multi-unit site).	Increased diesel generator availability.	AC/DC	BWR SAMA Candidates (NEI 1995)
20	Develop procedures for replenishing diesel fuel oil.	Increased diesel generator availability.	AC/DC	BWR SAMA Candidates (NEI 1995)
21	Use fire water system as a backup source for diesel cooling.	Increased diesel generator availability.	AC/DC	BWR SAMA Candidates (NEI 1995)
22	Add a new backup source of diesel cooling.	Increased diesel generator availability.	AC/DC	BWR SAMA Candidates (NEI 1995)
23	Develop procedures to repair or replace failed 4 KV breakers.	Increased probability of recovery from failure of breakers that transfer 4.16 kV non- emergency buses from unit station service transformers.	AC/DC	BWR SAMA Candidates (NEI 1995)
24	In training, emphasize steps in recovery of off-site power after an SBO.	Reduced human error probability during off-site power recovery.	AC/DC	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
25	Develop a severe weather conditions procedure.	Improved off-site power recovery following external weather-related events.	AC/DC	BWR SAMA Candidates (NEI 1995)
26	Bury off-site power lines.	Improved off-site power reliability during severe weather.	AC/DC	BWR SAMA Candidates (NEI 1995)
27	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	Core Cooling	BWR SAMA Candidates (NEI 1995)
28	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	Core Cooling	BWR SAMA Candidates (NEI 1995)
29	Raise HPCI/RCIC backpressure trip set points.	Increased HPCI and RCIC availability when high suppression pool temperature exists.	Core Cooling	BWR SAMA Candidates (NEI 1995)
30	Revise procedure to allow bypass of RCIC turbine exhaust pressure trip.	Extended RCIC operation.	Core Cooling	BWR SAMA Candidates (NEI 1995)
31	Revise procedure to allow intermittent operation of HPCI and RCIC.	Extended HPCI and RCIC operation.	Core Cooling	BWR SAMA Candidates (NEI 1995)
32	Revise procedure to control torus temperature, torus level, and primary containment pressure to increase available net positive suction head (NPSH) for injection pumps.	Increased probability that injection pumps will be available to inject coolant into the vessel.	Core Cooling	BWR SAMA Candidates (NEI 1995)
33	Revise procedure to manually initiate HPCI and RCIC given auto initiation failure.	Increased availability of HPCI and RCIC given auto initiation signal failure.	Core Cooling	BWR SAMA Candidates (NEI 1995)
34	Modify automatic depressurization system components to improve reliability.	Reduced frequency of high pressure core damage sequences.	Core Cooling	BWR SAMA Candidates (NEI 1995)
35	Add signals to open safety relief valves automatically in an MSIV closure transient.	Reduced likelihood of SRV failure to open in an MSIV closure transient reduces the probability of a medium LOCA.	Core Cooling	BWR SAMA Candidates (NEI 1995)
36	Revise procedure to allow manual initiation of emergency depressurization.	Improved prevention of core damage during transients, small and medium LOCAs, and ATWS.	Core Cooling	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
37	Revise procedure to allow operators to inhibit automatic vessel depressurization in non-ATWS scenarios.	Extended HPCI and RCIC operation.	Core Cooling	BWR SAMA Candidates (NEI 1995)
38	Add a diverse low pressure injection system.	Improved injection capability.	Core Cooling	BWR SAMA Candidates (NEI 1995)
39	Increase flow rate of suppression pool cooling.	Improved suppression pool cooling.	Core Cooling	BWR SAMA Candidates (NEI 1995)
40	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	Core Cooling	BWR SAMA Candidates (NEI 1995)
41	Provide capability for alternate injection via reactor water cleanup (RWCU).	Improved injection capability.	Core Cooling	BWR SAMA Candidates (NEI 1995)
42	Revise procedure to align EDG and allow use of essential CRD for vessel injection.	Improved injection capability.	Core Cooling	BWR SAMA Candidates (NEI 1995)
43	Revise procedure to allow use of condensate pumps for injection.	Improved injection capability.	Core Cooling	BWR SAMA Candidates (NEI 1995)
44	Revise procedure to allow use of suppression pool jockey pump for injection.	Improved injection capability	Core Cooling	BWR SAMA Candidates (NEI 1995)
45	Revise procedure to re-open MSIVs.	Regains the main condenser as a heat sink.	Core Cooling	BWR SAMA Candidates (NEI 1995)
46	Improve ECCS suction strainers to enhance reliability of ECCS suction.	Enhanced reliability of ECCS suction.	Core Cooling	BWR SAMA Candidates (NEI 1995)
47	Revise procedure to align LPCI or core spray to CST on loss of suppression pool cooling.	Improved injection in loss of suppression pool cooling scenarios.	Core Cooling	BWR SAMA Candidates (NEI 1995)
48	Remove LPCI loop select logic.	Enables use of LPCI A loop for injection in the event of a B injection path failure.	Core Cooling	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
49	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high-and low-pressure safety injection systems.	Cooling Water	BWR SAMA Candidates (NEI 1995)
50	Change procedures to allow cross connection of motor cooling for RHRSW pumps.	Continued operation of both RHRSW pumps on failure of one train of SW.	Cooling Water	BWR SAMA Candidates (NEI 1995)
51	Add redundant DC control power for SW pumps.	Increased availability of SW.	Cooling Water	BWR SAMA Candidates (NEI 1995)
52	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	Cooling Water	BWR SAMA Candidates (NEI 1995)
53	Provide self-cooled ECCS seals.	Elimination of ECCS dependency on component cooling system.	Cooling Water	BWR SAMA Candidates (NEI 1995)
54	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	Reduced frequency of loss of component cooling water and service water.	Cooling Water	BWR SAMA Candidates (NEI 1995)
55	Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers.	Improved ability to cool RHR heat exchangers.	Cooling Water	BWR SAMA Candidates (NEI 1995)
56	Add a service water pump.	Increased availability of cooling water.	Cooling Water	BWR SAMA Candidates (NEI 1995)
57	Enhance the screen wash system.	Reduced potential for loss of SW due to clogging of screens.	Cooling Water	BWR SAMA Candidates (NEI 1995)
58	Install a digital feedwater upgrade.	Reduced chance of loss of main feedwater following a plant trip.	Feedwater and Condensate	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
59	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	Feedwater and Condensate	BWR SAMA Candidates (NEI 1995)
60	Install an independent diesel for the condensate storage tank makeup pumps.	Extended inventory in CST during an SBO.	Feedwater and Condensate	BWR SAMA Candidates (NEI 1995)
61	Add a motor-driven feedwater pump.	Increased availability of feedwater.	Feedwater and Condensate	BWR SAMA Candidates (NEI 1995)
62	Provide reliable power to control building fans.	Increased availability of control room ventilation.	HVAC	BWR SAMA Candidates (NEI 1995)
63	Provide a redundant train or means of ventilation.	Increased availability of components dependent upon room cooling.	HVAC	BWR SAMA Candidates (NEI 1995)
64	Enhance procedures for actions on loss of HVAC.	Increased availability of components dependent on room cooling.	HVAC	BWR SAMA Candidates (NEI 1995)
65	Add a diesel building high temperature alarm or redundant louver and thermostat.	Improved diagnosis of a loss of diesel building HVAC.	HVAC	BWR SAMA Candidates (NEI 1995)
66	Create ability to switch HPCI and RCIC room fan power supply to DC in an SBO event.	Increased availability of HPCI and RCIC in an SBO event.	HVAC	BWR SAMA Candidates (NEI 1995)
67	Enhance procedure to trip unneeded RHR or CS pumps on loss of room ventilation.	Extended availability of required RHR or CS pumps due to reduction in room heat load.	HVAC	BWR SAMA Candidates (NEI 1995)
68	Stage backup fans in switchgear rooms.	Increased availability of ventilation in the event of a loss of switchgear ventilation.	HVAC	BWR SAMA Candidates (NEI 1995)
69	Add a switchgear room high temperature alarm.	Improved diagnosis of a loss of switchgear HVAC.	HVAC	BWR SAMA Candidates (NEI 1995)
70	Provide cross-unit connection of uninterruptible compressed air supply.	Increased ability to vent containment using the hardened vent.	IA/Nitrogen	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
71	Modify procedure to provide ability to align diesel power to more air compressors.	Increased availability of instrument air after a LOOP.	IA/Nitrogen	BWR SAMA Candidates (NEI 1995)
72	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on TBCCW and service water cooling.	IA/Nitrogen	BWR SAMA Candidates (NEI 1995)
73	Install nitrogen bottles as backup gas supply for safety relief valves.	Extended SRV operation time.	IA/Nitrogen	BWR SAMA Candidates (NEI 1995)
74	Improve SRV and MSIV pneumatic components.	Improved availability of SRVs and MSIVs.	IA/Nitrogen	BWR SAMA Candidates (NEI 1995)
75	Install an independent method of suppression pool cooling.	Increased availability of containment heat removal.	Containment Performance	BWR SAMA Candidates (NEI 1995)
76	Revise procedure to initiate suppression pool cooling during transients, LOCAs and ATWS.	Improved containment pressure control and containment heat removal capability.	Containment Performance	BWR SAMA Candidates (NEI 1995)
77	Cross-tie open cycle cooling system to enhance drywell spray system.	Increased availability of containment heat removal.	Containment Performance	BWR SAMA Candidates (NEI 1995)
78	Enable flooding of the drywell head seal.	Reduced probability of leakage through the drywell head seal.	Containment Performance	BWR SAMA Candidates (NEI 1995)
79	Create a reactor cavity flooding system.	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product.	Containment Performance	BWR SAMA Candidates (NEI 1995)
80	Install a passive drywell spray system.	Improved drywell spray capability.	Containment Performance	BWR SAMA Candidates (NEI 1995)
81	Use the fire water system as a backup source for the drywell spray system.	Improved drywell spray capability.	Containment Performance	BWR SAMA Candidates (NEI 1995)
82	Enhance procedures to refill CST from de-mineralized water or service water system.	Reduced risk of core damage during station blackouts or LOCAs that render the suppression pool unavailable as an injection source.	Containment Performance	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
83	Enhance procedure to maintain ECCS suction on CST as long as possible.	Reduced chance of pump failure due to high suppression pool temperature.	Containment Performance	BWR SAMA Candidates (NEI 1995)
84	Modify containment flooding procedure to restrict flooding to below the top of active fuel.	Reduced forced containment venting.	Containment Performance	BWR SAMA Candidates (NEI 1995)
85	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	Containment Performance	BWR SAMA Candidates (NEI 1995)
86	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter. Option 2: Multiple Venturi Scrubber.	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	Containment Performance	BWR SAMA Candidates (NEI 1995)
87	Enhance fire protection system and standby gas treatment system hardware and procedures.	Improved fission product scrubbing in severe accidents.	Containment Performance	BWR SAMA Candidates (NEI 1995)
88	Modify plant to permit suppression pool scrubbing.	Increased scrubbing of fission products by directing vent path through water in the suppression pool.	Containment Performance	BWR SAMA Candidates (NEI 1995)
89	Enhance containment venting procedures with respect to timing, path selection, and technique.	Improved likelihood of successful venting.	Containment Performance	BWR SAMA Candidates (NEI 1995)
90	Control containment venting within a narrow band of pressure.	Reduced probability of rapid containment depressurization thus avoiding adverse impact on low pressure injection systems that take suction from the torus.	Containment Performance	BWR SAMA Candidates (NEI 1995)
91	Improve vacuum breaker reliability by installing redundant valves in each line.	Decreased consequences of a vacuum breaker failure to reseat.	Containment Performance	BWR SAMA Candidates (NEI 1995)
92	Enhance air return fans (ice condenser plants).	Reduced probability of containment failure in SBO sequences.	Containment Performance	BWR SAMA Candidates (NEI 1995)
93	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	Containment Performance	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
94	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	Containment Performance	BWR SAMA Candidates (NEI 1995)
95	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	Containment Performance	BWR SAMA Candidates (NEI 1995)
96	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	Containment Performance	BWR SAMA Candidates (NEI 1995)
97	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	Containment Performance	BWR SAMA Candidates (NEI 1995)
98	Provide a reactor vessel exterior cooling system.	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water.	Containment Performance	BWR SAMA Candidates (NEI 1995)
99	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	Containment Performance	BWR SAMA Candidates (NEI 1995)
100	Institute simulator training for severe accident scenarios.	Improved arrest of core melt progress and prevention of containment failure.	Containment Performance	BWR SAMA Candidates (NEI 1995)
101	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	Containment Performance	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
102	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	Containment Performance	BWR SAMA Candidates (NEI 1995)
103	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	Containment Performance	BWR SAMA Candidates (NEI 1995)
104	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.	Containment Performance	BWR SAMA Candidates (NEI 1995)
105	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
106	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
107	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
108	Improve MSIV design.	Decreased likelihood of containment bypass scenarios.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
109	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
110	Locate residual heat removal (RHR) inside containment.	Reduced frequency of ISLOCA outside containment.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
111	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	Containment Bypass	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
112	Revise EOPs to improve ISLOCA identification.	Increased likelihood that LOCAs outside containment are identified as such. A plant had a scenario in which an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
113	Improve operator training on ISLOCA coping.	Decreased ISLOCA consequences.	Containment Bypass	BWR SAMA Candidates (NEI 1995)
114	Create cross-connect ability for standby liquid control (SLC) trains.	Improved availability of boron injection during ATWS.	ATWS	BWR SAMA Candidates (NEI 1995)
115	Revise procedures to control vessel injection to prevent boron loss or dilution following SLC injection.	Improved availability of boron injection during ATWS.	ATWS	BWR SAMA Candidates (NEI 1995)
116	Provide an alternate means of opening a pathway to the RPV for SLC injection.	Improved probability of reactor shutdown.	ATWS	BWR SAMA Candidates (NEI 1995)
117	Increase boron concentration or enrichment in the SLC system.	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	ATWS	BWR SAMA Candidates (NEI 1995)
118	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	ATWS	BWR SAMA Candidates (NEI 1995)
119	Provide ability to use control rod drive (CRD) or RWCU for alternate boron injection.	Improved availability of boron injection during ATWS.	ATWS	BWR SAMA Candidates (NEI 1995)
120	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	ATWS	BWR SAMA Candidates (NEI 1995)
121	Increase safety relief valve (SRV) reseat reliability.	Reduced risk of dilution of boron due to SRV failure to reseat after standby liquid control (SLC) injection.	ATWS	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
122	Provide an additional control system for rod insertion (e.g., AMSAC).	Improved redundancy and reduced ATWS frequency.	ATWS	BWR SAMA Candidates (NEI 1995)
123	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	ATWS	BWR SAMA Candidates (NEI 1995)
124	Revise procedure to bypass MSIV isolation in turbine trip ATWS scenarios.	Affords operators more time to perform actions. Discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities.	ATWS	BWR SAMA Candidates (NEI 1995)
125	Revise procedure to allow override of low pressure core injection during an ATWS event.	Allows immediate control of low pressure core injection. On failure of high pressure core injection and condensate, some plants direct reactor depressurization followed by five minutes of automatic low pressure core injection.	ATWS	BWR SAMA Candidates (NEI 1995)
126	Seal penetrations between turbine building basement and switchgear rooms.	Increased flood propagation prevention.	Flooding	BWR SAMA Candidates (NEI 1995)
127	Improve inspection of rubber expansion joints.	Reduced frequency of internal flooding due to failure of circulating water system expansion on main condenser joints.	Flooding	BWR SAMA Candidates (NEI 1995)
128	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	Prevents flood propagation.	Flooding	BWR SAMA Candidates (NEI 1995)
129	Increase seismic ruggedness of plant components.	Increased availability of necessary plant equipment during and after seismic events.	Seismic	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
130	Provide additional restraints for $C0_2$ tanks.	Increased availability of fire protection given a seismic event.	Seismic	BWR SAMA Candidates (NEI 1995)
131	Modify safety related condensate storage tank.	Improved availability of CST following a seismic event.	Seismic	BWR SAMA Candidates (NEI 1995)
132	Replace anchor bolts on diesel generator oil cooler.	Improved availability of diesel generators following a seismic event.	Seismic	BWR SAMA Candidates (NEI 1995)
133	Replace mercury switches in fire protection system.	Decreased probability of spurious fire suppression system actuation.	Fire	BWR SAMA Candidates (NEI 1995)
134	Upgrade fire compartment barriers.	Decreased consequences of a fire.	Fire	BWR SAMA Candidates (NEI 1995)
135	Install additional transfer and isolation switches.	Reduced number of spurious actuations during a fire.	Fire	BWR SAMA Candidates (NEI 1995)
136	Enhance procedures to use alternate shutdown methods if the control room becomes uninhabitable.	Increased probability of shutdown if the control room becomes uninhabitable.	Fire	BWR SAMA Candidates (NEI 1995)
137	Enhance fire brigade awareness.	Decreased consequences of a fire.	Fire	BWR SAMA Candidates (NEI 1995)
138	Enhance control of combustibles and ignition sources.	Decreased fire frequency and consequences.	Fire	BWR SAMA Candidates (NEI 1995)
139	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	Other	BWR SAMA Candidates (NEI 1995)
140	Enhance procedures to mitigate large break LOCA.	Reduced consequences of a large break LOCA.	Other	BWR SAMA Candidates (NEI 1995)
141	Install computer aided instrumentation system to assist the operator in assessing post-accident plant status.	Improved prevention of core melt sequences by making operator actions more reliable.	Other	BWR SAMA Candidates (NEI 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
142	Improve maintenance procedures.	Improved prevention of core melt sequences by increasing reliability of important equipment.	Other	BWR SAMA Candidates (NEI 1995)
143	Increase training and operating experience feedback to improve operator response.	Improved likelihood of success of operator actions taken in response to abnormal conditions.	Other	BWR SAMA Candidates (NEI 1995)
144	Develop procedures for transportation and nearby facility accidents.	Reduced consequences of transportation and nearby facility accidents.	Other	BWR SAMA Candidates (NEI 1995)
145	Develop AOP or EOP for response to total loss of DC power. Many of the control breakers in the plant that require DC power are stored energy breakers that can be locally operated. Other strategies would include using EHC panel power to manually jack open the TBVs in order to depressurize, taking local manual control of the RCIC system, and using portable generators to power essential DC loads.	Improved mitigation of total loss of DC power events.	IPE	DAEC IPE (IELP 1992)
146	Consider revision to the EOP direction to terminate injection to the RPV from sources external to the drywell, irrespective of core cooling, in loss of containment heat removal scenarios where the Maximum Primary Containment Water Level Limit (MPCWLL) is reached.	Enhance ability to mitigate long term containment heatup scenarios.	IPE	DAEC IPE (IELP 1992)
147	Maintain heightened awareness of the operations staff of the importance of timely injection of Standby Liquid Control in ATWS scenarios.	Eliminate scenarios in which SLC initiation is delayed in ATWS conditions to prevent containment damage and subsequent core failure.	IPE	DAEC IPE (IELP 1992)
148	Provide a procedure with a tested lineup that will allow the use of the diesel fire pump to inject to the RPV in extended loss of AC power scenarios. Also provide direction to maintain sufficient DC power reserve to keep the containment and RPV a low enough pressure for the firewater to RPV lineup to be successful.	Better mitigation of extended loss of AC power events.	IPE	DAEC IPE (IELP 1992)
149	Change EOPs to allow the use of Drywell Spray as well as removing ambiguity regarding the diversion of injection sources away from the RPV when adequate core cooling is not assured.	Initiation of drywell spray prior to RPV breach would preclude the debris attack and failure of the drywell shell.	IPE	DAEC IPE (IELP 1992)
150	Relaxation of the restrictions on the use of the drywell sprays in the DWSI curve of the EOPs may be a possible future accident management item.	Drywell sprays offer an additional alternative to the control of the drywell temperature to avoid premature containment failure.	IPE	DAEC IPE (IELP 1992)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
151	Provide accident management strategies that provide guidance to the operators on protecting containment and cooling debris using methods that do not require the venting of the RPV and avoid using the drywell vent unless no other alternative exists.	Reduction in the amount of release through the containment vents early in the accident.	IPE	DAEC IPE (IELP 1992)
152	One masonry block wall was identified that was not included in the NRC IE Bulletin 80-11 program as a masonry wall that could potentially damage Safe Shutdown Equipment List equipment.	Prevent damage to safety related equipment during a seismic event.	IPEEE	DAEC IPEEE (IES 1995)
153	Portions of the control room ceiling may not have adequate restraint of the membranes nor adequate strength in the connections to preclude potential falling of ceiling elements onto critical equipment during a seismic loading.	Prevent damage to safety related equipment during a seismic event.	IPEEE	DAEC IPEEE (IES 1995)
154	Problems identified with the adequacy of seismic equipment anchorages during field walkdowns and UT examinations.	Prevent damage to safety related equipment during a seismic event.	IPEEE	DAEC IPEEE (IES 1995)
155	Two air handlers in the HPCI room were identified as seismically induced flood/spray outliers because nearby piping could potentially impact fire protection sprinkler piping and break off the sprinkler heads, which could damage the air handler motors.	Prevent damage to equipment from post-seismic event flooding/spray.	IPEEE	DAEC IPEEE (IES 1995)
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.	Cooling Water	Expert Panel
157	Three areas were identified that have gas storage bottles that were not adequately restrained against seismic events.	Prevent damage to equipment from nearby gas bottles post seismic event.	IPEEE	DAEC IPEEE (IES 1995)
158	Prohibit any work in the switchgear room supporting the operating river water train during any maintenance on the river water system.	Reduce the fire ignition frequency in the switchgear room supporting the operable river water train.	IPEEE	DAEC IPEEE (IES 1995)
159	Post a fire watch in the switchgear room supporting the operating river water train, or stage temporary hoses for implementation of AOP-410, Total Loss of River Water.	Maximize the ability to respond to and mitigate a fire in the switchgear room supporting the operable river water train.	IPEEE	DAEC IPEEE (IES 1995)
160	Modify piping design to eliminate the flooding sequences from the fire protection piping in the control building HVAC room above the control room.	Eliminate or reduce the damage caused by flooding from rupture of this fire protection piping.	IPEEE	DAEC IPEEE (IES 1995)
161	Increase the distance of installation of a new hydrogen storage tank from safety related structures.	Minimize damages to safety related equipment from fires/explosions in the new hydrogen storage facility.	IPEEE	DAEC IPEEE (IES 1995)

Table 5.5-1 List of SAMA Candidates (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
162	Install concrete barriers around the auxiliary boiler propane tank.	Eliminate the risk of propane tank damage and subsequent fire/explosion caused by vehicle impacts on the propane tank.	IPEEE	DAEC IPEEE (IES 1995)
163	Improve the reliability of the RWS system control valves CV4914 and CV4915.	Decreased risk due to failures of the RWS system. (High PRA importance list.)	PRA	DAEC PRA Rev 5C (FPL 2007b)
164	Improve the reliability of the RWS control system.	Decreased risk due to failures of the RWS system. (High PRA importance list - HS- 4914.)	PRA	DAEC PRA Rev 5C (FPL 2007b)
165	Improve the reliability of the RHRSW loop differential pressure indicators.	Decreased risk due to failures of the RHRSW system. (High PRA importance list.)	PRA	DAEC PRA Rev 5C (FPL 2007b)
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)	PRA	DAEC PRA Rev 5C (FPL 2007b)

6 PHASE I ANALYSIS

A preliminary screening of the complete list of SAMA candidates was performed to limit the number of SAMAs for which detailed analysis in Phase II was necessary. The screening criteria used in the Phase I analysis are described below.

- ***Screening Criterion A - Not Applicable***: If a SAMA candidate did not apply to the DAEC plant design, it was not retained.
- ***Screening Criterion B - Already Implemented***: If a SAMA candidate had already been implemented at DAEC, it was not retained.
- ***Screening Criterion C - Combined***: If a SAMA candidate was similar in nature and could be combined with another SAMA candidate to develop a more comprehensive or plant-specific SAMA candidate, only the combined SAMA candidate was retained.
- ***Screening Criterion D - Excessive Implementation Cost***: If a SAMA required extensive changes that will obviously exceed the maximum benefit (Section 4.5), even without an implementation cost estimate, it was not retained.
- ***Screening Criterion E - Very Low Benefit***: If a SAMA from an industry document was related to a non-risk significant system for which change in reliability is known to have negligible impact on the risk profile, it was not retained. (No SAMAs were screened using this criterion.)

Table 6-1 presents the list of Phase I SAMA candidates and provides the disposition of each candidate along with the applicable screening criterion associated with each candidate. Those candidates that have not been screened by application of these criteria are evaluated further in the Phase II analysis (Section 7). It can be seen from this table that 142 SAMAs were screened from the analysis during Phase 1 and that 24 SAMAs passed into the next phase of the analysis.

Table 6-1 DAEC Phase I SAMA Analysis

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
13	Create AC power cross-tie capability with other unit (multi-unit site).	Increased availability of on-site AC power.	Yes	A - Not Applicable	N/A. Single Unit.
16	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	Yes	A - Not Applicable	N/A. Do not have a gas turbine.
19	Create a cross-tie for diesel fuel oil (multi-unit site).	Increased diesel generator availability.	Yes	A - Not Applicable	N/A. Single Unit.
29	Raise HPCI/RCIC backpressure trip set points.	Increased HPCI and RCIC availability when high suppression pool temperature exists.	Yes	A - Not Applicable	The HPCI high backpressure trip is already set at a pressure above the containment ultimate pressure; thus, raising the trip limit would have very limited impact. The RCIC trip limit could be increased or bypassed, but the benefit would also be small because RPV depressurization is required before containment conditions are above these back pressure set points. Therefore, no benefit is gained from increasing these numerical values.
30	Revise procedure to allow bypass of RCIC turbine exhaust pressure trip.	Extended RCIC operation.	Yes	A - Not Applicable	The RCIC trip limit could be increased or bypassed, but the benefit would also be small because RPV depressurization is required before containment conditions are above these back pressure set points. Therefore, no benefit is gained from increasing these numerical values.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
44	Revise procedure to allow use of suppression pool jockey pump for injection.	Improved injection capability	Yes	A - Not Applicable	Flow rate too low, only 50 gpm.
53	Provide self-cooled ECCS seals.	Elimination of ECCS dependency on component cooling system.	Yes	A - Not Applicable	Seal cooling is not required for injection or containment heat removal. Seal cooling is only needed during the initial stages of shutdown cooling operation.
57	Enhance the screen wash system.	Reduced potential for loss of SW due to clogging of screens.	Yes	A - Not Applicable	Currently a reliable system. Fire water and well water are available as backup for maintaining level in the safety-related pump pit.
67	Enhance procedure to trip unneeded RHR or CS pumps on loss of room ventilation.	Extended availability of required RHR or CS pumps due to reduction in room heat load.	Yes	A - Not Applicable	Not needed. Pumps can run for several days without room cooling.
70	Provide cross-unit connection of uninterruptible compressed air supply.	Increased ability to vent containment using the hardened vent.	Yes	A - Not Applicable	N/A. Single unit.
92	Enhance air return fans (ice condenser plants).	Reduced probability of containment failure in SBO sequences.	Yes	A - Not Applicable	N/A. No ice condenser.
102	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	Yes	A - Not Applicable	N/A. Inerted drywell.
103	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	Yes	A - Not Applicable	N/A. Inerted drywell.
111	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	Yes	A - Not Applicable	The majority of piping the for these leakage paths is too high the room for this to be effective.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
114	Create cross-connect ability for standby liquid control (SLC) trains.	Improved availability of boron injection during ATWS.	Yes	A - Not Applicable	N/A. Do not have two inject paths. See 118.
126	Seal penetrations between turbine building basement and switchgear rooms.	Increased flood propagation prevention.	Yes	A - Not Applicable	N/A. Essential switchgear room not below ground level. Half of non-essential switchgear is below ground level. See SAMA 155 and 160 for plant specific flooding issues.
128	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	Prevents flood propagation.	Yes	A - Not Applicable	N/A. Essential switchgear room not below ground level. Half of non-essential switchgear is below ground level. See SAMA 155 and 160 for plant specific flooding issues.
130	Provide additional restraints for C0 2 tanks.	Increased availability of fire protection given a seismic event.	Yes	A - Not Applicable	CO2 tanks not identified as an issue in seismic studies and walkdowns.
132	Replace anchor bolts on diesel generator oil cooler.	Improved availability of diesel generators following a seismic event.	Yes	A - Not Applicable	Diesel bolting not identified as an issue in seismic walkdowns and studies.
134	Upgrade fire compartment barriers.	Decreased consequences of a fire.	Yes	A - Not Applicable	See SAMAs 155, 158, 159, 161, and 162 for plant specific fire issues.
135	Install additional transfer and isolation switches.	Reduced number of spurious actuations during a fire.	Yes	A - Not Applicable	See SAMAs 155, 158, 159, 161, and 162 for plant specific fire issues.
144	Develop procedures for transportation and nearby facility accidents.	Reduced consequences of transportation and nearby facility accidents.	Yes	A - Not Applicable	DAEC is isolated, with no industrial facilities nearby. Local transportation routes analyzed and determined to be acceptable by the Control Room Habitability Study.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
165	Improve the reliability of the RHRSW loop differential pressure indicators.	Decreased risk due to failures of the RHRSW system. (High PRA importance list.)	Yes	A - Not Applicable	The PRA model does not reflect a modification for removal of the automatic control function for delta pressure across the heat exchanger. This causes these components to have an artificially high risk reduction worth.
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO.	Yes	B - Implemented OR Intent Met	Implemented through SAMG.
3	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.	Improved availability of DC power system.	Yes	B - Implemented OR Intent Met	Implemented through SAMG.
4	Improve DC bus load shedding.	Extended DC power availability during an SBO.	Yes	B - Implemented OR Intent Met	Load shedding is in procedure.
6	Provide additional DC power to the 120/240V vital AC system.	Increased availability of the 120 V vital AC bus.	Yes	B - Implemented OR Intent Met	Implemented.
7	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.	Increased availability of the 120 V vital AC bus.	Yes	B - Implemented OR Intent Met	Implemented.
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	Improved chances of successful response to loss of two 120V AC buses.	Yes	B - Implemented OR Intent Met	Operators trained biennially.
9	Reduce DC dependence between high-pressure injection system and ADS.	Improved containment depressurization and high-pressure injection following DC failure.	Yes	B - Implemented OR Intent Met	Implemented through an alternate mitigation strategy.
11	Revise procedure to allow bypass of diesel generator trips.	Extended diesel generator operation.	Yes	B - Implemented OR Intent Met	If Emergency Start signal is present, the only diesel trip would come from a generator lock out or overspeed.
18	Improve uninterruptible power supplies.	Increased availability of power supplies supporting front-line equipment.	Yes	B - Implemented OR Intent Met	Upgraded UPS installed. Isolator fuses installed.
20	Develop procedures for replenishing diesel fuel oil.	Increased diesel generator availability.	Yes	B - Implemented OR Intent Met	Procedures in place.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
21	Use fire water system as a backup source for diesel cooling.	Increased diesel generator availability.	Yes	B - Implemented OR Intent Met	Procedures in place.
22	Add a new backup source of diesel cooling.	Increased diesel generator availability.	Yes	B - Implemented OR Intent Met	EOPs contain guidance for cross-tie to other water sources.
23	Develop procedures to repair or replace failed 4 KV breakers.	Increased probability of recovery from failure of breakers that transfer 4.16 kV non-emergency buses from unit station service transformers.	Yes	B - Implemented OR Intent Met	In place.
24	In training, emphasize steps in recovery of off-site power after an SBO.	Reduced human error probability during off-site power recovery.	Yes	B - Implemented OR Intent Met	In place.
25	Develop a severe weather conditions procedure.	Improved off-site power recovery following external weather-related events.	Yes	B - Implemented OR Intent Met	In place.
31	Revise procedure to allow intermittent operation of HPCI and RCIC.	Extended HPCI and RCIC operation.	Yes	B - Implemented OR Intent Met	In place.
32	Revise procedure to control torus temperature, torus level, and primary containment pressure to increase available net positive suction head (NPSH) for injection pumps.	Increased probability that injection pumps will be available to inject coolant into the vessel.	Yes	B - Implemented OR Intent Met	Procedures in place.
33	Revise procedure to manually initiate HPCI and RCIC given auto initiation failure.	Increased availability of HPCI and RCIC given auto initiation signal failure.	Yes	B - Implemented OR Intent Met	System operating instructions have guidance for HPCI and RCIC. RCIC includes instructions for operating system with no power available.
34	Modify automatic depressurization system components to improve reliability.	Reduced frequency of high pressure core damage sequences.	Yes	B - Implemented OR Intent Met	Procedures in place.
36	Revise procedure to allow manual initiation of emergency depressurization.	Improved prevention of core damage during transients, small and medium LOCAs, and ATWS.	Yes	B - Implemented OR Intent Met	EOPs provide guidance for manual initiation of depressurization and for alternate means of depressurization.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
37	Revise procedure to allow operators to inhibit automatic vessel depressurization in non-ATWS scenarios.	Extended HPCI and RCIC operation.	Yes	B - Implemented OR Intent Met	EOP in place.
38	Add a diverse low pressure injection system.	Improved injection capability.	Yes	B - Implemented OR Intent Met	Procedures in place.
40	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	Yes	B - Implemented OR Intent Met	Injection using existing fire pump is current EOP implementing procedures. Also can use a new portable diesel powered pump.
42	Revise procedure to align EDG and allow use of essential CRD for vessel injection.	Improved injection capability.	Yes	B - Implemented OR Intent Met	Procedures in place.
43	Revise procedure to allow use of condensate pumps for injection.	Improved injection capability.	Yes	B - Implemented OR Intent Met	Procedures in place.
45	Revise procedure to re-open MSIVs.	Regains the main condenser as a heat sink.	Yes	B - Implemented OR Intent Met	Procedures in place.
46	Improve ECCS suction strainers to enhance reliability of ECCS suction.	Enhanced reliability of ECCS suction.	Yes	B - Implemented OR Intent Met	Done.
47	Revise procedure to align LPCI or core spray to CST on loss of suppression pool cooling.	Improved injection in loss of suppression pool cooling scenarios.	Yes	B - Implemented OR Intent Met	Core Spray can be aligned. LPCI cannot.
48	Remove LPCI loop select logic.	Enables use of LPCI A loop for injection in the event of a B injection path failure.	Yes	B - Implemented OR Intent Met	Current licensing action.
50	Change procedures to allow cross connection of motor cooling for RHRSW pumps.	Continued operation of both RHRSW pumps on failure of one train of SW.	Yes	B - Implemented OR Intent Met	ESW loops can be cross-tied, spool piece staged in pumphouse.
54	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	Reduced frequency of loss of component cooling water and service water.	Yes	B - Implemented OR Intent Met	Hardware exists, procedure in place for diesel.
58	Install a digital feedwater upgrade.	Reduced chance of loss of main feedwater following a plant trip.	Yes	B - Implemented OR Intent Met	Have in place.
59	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	Yes	B - Implemented OR Intent Met	Implemented through an alternate mitigation strategy.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
60	Install an independent diesel for the condensate storage tank makeup pumps.	Extended inventory in CST during an SBO.	Yes	B - Implemented OR Intent Met	Implemented through an alternate mitigation strategy.
61	Add a motor-driven feedwater pump.	Increased availability of feedwater.	Yes	B - Implemented OR Intent Met	Feedwater pumps are motor driven.
62	Provide reliable power to control building fans.	Increased availability of control room ventilation.	Yes	B - Implemented OR Intent Met	Control Building HVAC runs off essential power.
63	Provide a redundant train or means of ventilation.	Increased availability of components dependent upon room cooling.	Yes	B - Implemented OR Intent Met	In place.
64	Enhance procedures for actions on loss of HVAC.	Increased availability of components dependent on room cooling.	Yes	B - Implemented OR Intent Met	In place.
65	Add a diesel building high temperature alarm or redundant louver and thermostat.	Improved diagnosis of a loss of diesel building HVAC.	Yes	B - Implemented OR Intent Met	Alarm exists.
66	Create ability to switch HPCI and RCIC room fan power supply to DC in an SBO event.	Increased availability of HPCI and RCIC in an SBO event.	Yes	B - Implemented OR Intent Met	Procedure bypasses temperature trips. RCIC will run with no ventilation. Need to open HPCI door.
68	Stage backup fans in switchgear rooms.	Increased availability of ventilation in the event of a loss of switchgear ventilation.	Yes	B - Implemented OR Intent Met	Have alternate fans and procedure.
69	Add a switchgear room high temperature alarm.	Improved diagnosis of a loss of switchgear HVAC.	Yes	B - Implemented OR Intent Met	Same cooling as control room. High temperatures would be noticed by operators well before alarm comes in.
71	Modify procedure to provide ability to align diesel power to more air compressors.	Increased availability of instrument air after a LOOP.	Yes	B - Implemented OR Intent Met	If essential bus is powered, already in place.
72	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on TBCCW and service water cooling.	Yes	B - Implemented OR Intent Met	Compressors are self cooled.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
73	Install nitrogen bottles as backup gas supply for safety relief valves.	Extended SRV operation time.	Yes	B - Implemented OR Intent Met	Accumulators exist on every valve. Additionally, there are header connections outside the drywell for connection of portable bottles.
74	Improve SRV and MSIV pneumatic components.	Improved availability of SRVs and MSIVs.	Yes	B - Implemented OR Intent Met	Implemented. MSIVs upgraded in 1990s. MSIVs and SRVs are subject to a PM Program and EQ part replacement program.
76	Revise procedure to initiate suppression pool cooling during transients, LOCAs and ATWS.	Improved containment pressure control and containment heat removal capability.	Yes	B - Implemented OR Intent Met	Procedures in place.
77	Cross-tie open cycle cooling system to enhance drywell spray system.	Increased availability of containment heat removal.	Yes	B - Implemented OR Intent Met	Procedures in place.
79	Create a reactor cavity flooding system.	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product.	Yes	B - Implemented OR Intent Met	Procedures provide guidance on debris cooling.
81	Use the fire water system as a backup source for the drywell spray system.	Improved drywell spray capability.	Yes	B - Implemented OR Intent Met	Covered in EOP support procedures.
82	Enhance procedures to refill CST from de-mineralized water or service water system.	Reduced risk of core damage during station blackouts or LOCAs that render the suppression pool unavailable as an injection source.	Yes	B - Implemented OR Intent Met	EMGs in place.
83	Enhance procedure to maintain ECCS suction on CST as long as possible.	Reduced chance of pump failure due to high suppression pool temperature.	Yes	B - Implemented OR Intent Met	Procedure exists to bypass HPCI high torus water level suction swap. RCIC does not swap suctions based on torus level. Core spray suction can be aligned to CST.
84	Modify containment flooding procedure to restrict flooding to below the top of active fuel.	Reduced forced containment venting.	Yes	B - Implemented OR Intent Met	Procedures in place.
85	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	Yes	B - Implemented OR Intent Met	Done.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
87	Enhance fire protection system and standby gas treatment system hardware and procedures.	Improved fission product scrubbing in severe accidents.	Yes	B - Implemented OR Intent Met	Guidance provided in current procedures.
88	Modify plant to permit suppression pool scrubbing.	Increased scrubbing of fission products by directing vent path through water in the suppression pool.	Yes	B - Implemented OR Intent Met	Included in EOPs. Vent paths from suppression pool airspace are preferred.
89	Enhance containment venting procedures with respect to timing, path selection, and technique.	Improved likelihood of successful venting.	Yes	B - Implemented OR Intent Met	EOP-2 Appendix C to Technical Support Guide.
90	Control containment venting within a narrow band of pressure.	Reduced probability of rapid containment depressurization thus avoiding adverse impact on low pressure injection systems that take suction from the torus.	Yes	B - Implemented OR Intent Met	Procedures in place.
91	Improve vacuum breaker reliability by installing redundant valves in each line.	Decreased consequences of a vacuum breaker failure to reseat.	Yes	B - Implemented OR Intent Met	Two active and two swing valves on each line.
93	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	Yes	B - Implemented OR Intent Met	Containment is inerted prior to event with the capability of replenishing the Nitrogen at low containment pressures.
98	Provide a reactor vessel exterior cooling system.	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water.	Yes	B - Implemented OR Intent Met	Procedures in place.
100	Institute simulator training for severe accident scenarios.	Improved arrest of core melt progress and prevention of containment failure.	Yes	B - Implemented OR Intent Met	Covered in SAM training program.
101	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	Yes	B - Implemented OR Intent Met	Currently have leak detection systems monitor the drywell with requirements for monitoring. Outside the primary containment, there are room flooding indicators and other means of detecting leaks.
105	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	Yes	B - Implemented OR Intent Met	ISLOCA paths already have pressure monitoring instrumentation installed.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
108	Improve MSIV design.	Decreased likelihood of containment bypass scenarios.	Yes	B - Implemented OR Intent Met	Improved in 1990.
110	Locate residual heat removal (RHR) inside containment.	Reduced frequency of ISLOCA outside containment.	Yes	B - Implemented OR Intent Met	Pumps are within secondary containment.
112	Revise EOPs to improve ISLOCA identification.	Increased likelihood that LOCAs outside containment are identified as such. A plant had a scenario in which an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Yes	B - Implemented OR Intent Met	EOPs and SAGs address this.
113	Improve operator training on ISLOCA coping.	Decreased ISLOCA consequences.	Yes	B - Implemented OR Intent Met	Done, EOP training covers this topic.
115	Revise procedures to control vessel injection to prevent boron loss or dilution following SLC injection.	Improved availability of boron injection during ATWS.	Yes	B - Implemented OR Intent Met	ATWS EOPs in place.
116	Provide an alternate means of opening a pathway to the RPV for SLC injection.	Improved probability of reactor shutdown.	Yes	B - Implemented OR Intent Met	Procedures in place.
118	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	Yes	B - Implemented OR Intent Met	Procedures in place.
119	Provide ability to use control rod drive (CRD) or RWCU for alternate boron injection.	Improved availability of boron injection during ATWS.	Yes	B - Implemented OR Intent Met	Procedures in place.
121	Increase safety relief valve (SRV) reseat reliability.	Reduced risk of dilution of boron due to SRV failure to reseat after standby liquid control (SLC) injection.	Yes	B - Implemented OR Intent Met	Process monitoring program in place to monitor SRV health. PM program in place for the SRVs.
122	Provide an additional control system for rod insertion (e.g., AMSAC).	Improved redundancy and reduced ATWS frequency.	Yes	B - Implemented OR Intent Met	ARI system installed.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
124	Revise procedure to bypass MSIV isolation in turbine trip ATWS scenarios.	Affords operators more time to perform actions. Discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities.	Yes	B - Implemented OR Intent Met	Procedures in place.
125	Revise procedure to allow override of low pressure core injection during an ATWS event.	Allows immediate control of low pressure core injection. On failure of high pressure core injection and condensate, some plants direct reactor depressurization followed by five minutes of automatic low pressure core injection.	Yes	B - Implemented OR Intent Met	Procedures in place.
127	Improve inspection of rubber expansion joints.	Reduced frequency of internal flooding due to failure of circulating water system expansion on main condenser. joints.	Yes	B - Implemented OR Intent Met	Inspected every refueling outage. Program in place to replace before prior to end of life expectancy.
129	Increase seismic ruggedness of plant components.	Increased availability of necessary plant equipment during and after seismic events.	Yes	B - Implemented OR Intent Met	Done after Seismic Qualification Utilities Group Inspection. Also see SAMAs 152, 153, 154, 155, and 157 for plant specific seismic issues.
131	Modify safety related condensate storage tank.	Improved availability of CST following a seismic event.	Yes	B - Implemented OR Intent Met	Although not safety related, the CST is bolted in order to sustain seismic event.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
133	Replace mercury switches in fire protection system.	Decreased probability of spurious fire suppression system actuation.	Yes	B - Implemented OR Intent Met	Per IPEEE, the only mercury switches in the control circuitry of the DAEC fire protection systems are associated with the diesel-driven fire pump and jockey pump low pressure initiation logic. This control circuitry in no way influences potential suppression system actuations.
136	Enhance procedures to use alternate shutdown methods if the control room becomes uninhabitable.	Increased probability of shutdown if the control room becomes uninhabitable.	Yes	B - Implemented OR Intent Met	Implemented using an alternate mitigation strategy.
137	Enhance fire brigade awareness.	Decreased consequences of a fire.	Yes	B - Implemented OR Intent Met	The fire brigade training and procedures meet current industry standards.
138	Enhance control of combustibles and ignition sources.	Decreased fire frequency and consequences.	Yes	B - Implemented OR Intent Met	Procedures in place.
140	Enhance procedures to mitigate large break LOCA.	Reduced consequences of a large break LOCA.	Yes	B - Implemented OR Intent Met	EOPs and SAGs in place.
141	Install computer aided instrumentation system to assist the operator in assessing post-accident plant status.	Improved prevention of core melt sequences by making operator actions more reliable.	Yes	B - Implemented OR Intent Met	Done SPDS.
142	Improve maintenance procedures.	Improved prevention of core melt sequences by increasing reliability of important equipment.	Yes	B - Implemented OR Intent Met	Continuous improvement program in progress.
143	Increase training and operating experience feedback to improve operator response.	Improved likelihood of success of operator actions taken in response to abnormal conditions.	Yes	B - Implemented OR Intent Met	Current program meets current industry guidance.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
145	Develop AOP or EOP for response to total loss of DC power. Many of the control breakers in the plant that require DC power are stored energy breakers that can be locally operated. Other strategies would include using EHC panel power to manually jack open the TBVs in order to depressurize, taking local manual control of the RCIC system, and using portable generators to power essential DC loads.	Improved mitigation of total loss of DC power events.	Yes	B - Implemented OR Intent Met	Procedures exist for total loss of DC power, depressurization using alternate power to the TBVs, and operation of RCIC without DC power.
146	Consider revision to the EOP direction to terminate injection to the RPV from sources external to the drywell, irrespective of core cooling, in loss of containment heat removal scenarios where the Maximum Primary Containment Water Level Limit (MPCWLL) is reached.	Enhance ability to mitigate long term containment heatup scenarios.	Yes	B - Implemented OR Intent Met	Guidance in EOPs.
147	Maintain heightened awareness of the operations staff of the importance of timely injection of Standby Liquid Control in ATWS scenarios.	Eliminate scenarios in which SLC initiation is delayed in ATWS conditions to prevent containment damage and subsequent core failure.	Yes	B - Implemented OR Intent Met	Included in operator training program.
148	Provide a procedure with a tested lineup that will allow the use of the diesel fire pump to inject to the RPV in extended loss of AC power scenarios. Also provide direction to maintain sufficient DC power reserve to keep the containment and RPV a low enough pressure for the firewater to RPV lineup to be successful.	Better mitigation of extended loss of AC power events.	Yes	B - Implemented OR Intent Met	Procedures in place.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
149	Change EOPs to allow the use of Drywell Spray as well as removing ambiguity regarding the diversion of injection sources away from the RPV when adequate core cooling is not assured.	Initiation of drywell spray prior to RPV breach would preclude the debris attack and failure of the drywell shell.	Yes	B - Implemented OR Intent Met	Procedures in place.
150	Relaxation of the restrictions on the use of the drywell sprays in the DWSI curve of the EOPs may be a possible future accident management item.	Drywell sprays offer an additional alternative to the control of the drywell temperature to avoid premature containment failure.	Yes	B - Implemented OR Intent Met	Procedures in place.
151	Provide accident management strategies that provide guidance to the operators on protecting containment and cooling debris using methods that do not require the venting of the RPV and avoid using the drywell vent unless no other alternative exists.	Reduction in the amount of release through the containment vents early in the accident.	Yes	B - Implemented OR Intent Met	Procedure in place.
152	One masonry block wall was identified that was not included in the NRC IE Bulletin 80-11 program as a masonry wall that could potentially damage Safe Shutdown Equipment List equipment.	Prevent damage to safety related equipment during a seismic event.	Yes	B - Implemented OR Intent Met	Already Implemented. The wall was added to the list and qualified.
153	Portions of the control room ceiling may not have adequate restraint of the membranes nor adequate strength in the connections to preclude potential falling of ceiling elements onto critical equipment during a seismic loading.	Prevent damage to safety related equipment during a seismic event.	Yes	B - Implemented OR Intent Met	Already Implemented. Selected elements of the control room ceiling were modified.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
154	Problems identified with the adequacy of seismic equipment anchorages during field walkdowns and UT examinations.	Prevent damage to safety related equipment during a seismic event.	Yes	B - Implemented OR Intent Met	Already Implemented. Some identified anchorages were qualified by analysis to use as-is, the remaining issues were resolved by maintenance actions or modifications.
155	Two air handlers in the HPCI room were identified as seismically induced flood/spray outliers because nearby piping could potentially impact fire protection sprinkler piping and break off the sprinkler heads, which could damage the air handler motors.	Prevent damage to equipment from post-seismic event flooding/spray.	Yes	B - Implemented OR Intent Met	Already Implemented. Further analysis shows that clearances between equipment are sufficient to preclude impact.
157	Three areas were identified that have gas storage bottles that were not adequately restrained against seismic events.	Prevent damage to equipment from nearby gas bottles post seismic event.	Yes	B - Implemented OR Intent Met	Already Implemented. Gas bottles were either removed or additional restraint provided.
158	Prohibit any work in the switchgear room supporting the operating river water train during any maintenance on the river water system.	Reduce the fire ignition frequency in the switchgear room supporting the operable river water train.	Yes	B - Implemented OR Intent Met	Maintenance risk management program provides for protection of certain systems when maintenance is being performed.
159	Post a fire watch in the switchgear room supporting the operating river water train, or stage temporary hoses for implementation of AOP-410, Total Loss of River Water.	Maximize the ability to respond to and mitigate a fire in the switchgear room supporting the operable river water train.	Yes	B - Implemented OR Intent Met	Maintenance risk management program provides for protection of certain systems when maintenance is being performed.
160	Modify piping design to eliminate the flooding sequences from the fire protection piping in the control building HVAC room above the control room.	Eliminate or reduce the damage caused by flooding from rupture of this fire protection piping.	Yes	B - Implemented OR Intent Met	Already Implemented. These fire protection systems were changed to "dry pipe" systems.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
161	Increase the distance of installation of a new hydrogen storage tank from safety related structures.	Minimize damages to safety related equipment from fires/explosions in the new hydrogen storage facility.	Yes	B - Implemented OR Intent Met	Already Implemented. The new tank was sited properly in relation to safety related structures. The new location was determined to be in accordance with EPRI guidelines and to be consistent with recommendations in GL 93-06.
162	Install concrete barriers around the auxiliary boiler propane tank.	Eliminate the risk of propane tank damage and subsequent fire/explosion caused by vehicle impacts on the propane tank.	Yes	B - Implemented OR Intent Met	Already Implemented. Concrete barriers installed.
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	Yes	C - Combined	Combine with SAMA 3.
5	Provide DC bus cross-ties.	Improved availability of DC power system.	Yes	C - Combined	Combine with SAMA 3.
14	Install an additional, buried off-site power source.	Reduced probability of loss of off-site power.	Yes	D - Excess Cost	Standby Transformer already underground. A line to the nearest offsite black start unit would exceed 50 miles.
26	Bury off-site power lines.	Improved off-site power reliability during severe weather.	Yes	D - Excess Cost	Standby Transformer already underground. A line to the nearest offsite black start unit would exceed 50 miles.
51	Add redundant DC control power for SW pumps.	Increased availability of SW.	Yes	D - Excess Cost	Cost would exceed maximum benefit. Mods would be required for RHRSW, ESW, and RWS.
80	Install a passive drywell spray system.	Improved drywell spray capability.	Yes	D - Excess Cost	Excess Cost.
86	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter. Option 2: Multiple Venturi Scrubber.	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	Yes	D - Excess Cost	Cost will exceed maximum benefit.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
94	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	Yes	D - Excess Cost	Excess Cost.
95	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	Yes	D - Excess Cost	Excess Cost.
96	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	Yes	D - Excess Cost	Excess Cost.
97	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	Yes	D - Excess Cost	Excess Cost.
99	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	Yes	D - Excess Cost	Excess Cost.
104	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.	Yes	D - Excess Cost	Excess Cost.
106	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	Yes	D - Excess Cost	Cost would exceed MAB.
109	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	Yes	D - Excess Cost	Modification cost would exceed maximum benefit.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
10	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	No		Retain for Phase II analysis. Could conceivably use TSC Diesel. However, there are no plans to do so.
12	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	No		Retain for Phase II analysis.
15	Install a gas turbine generator.	Increased availability of on-site AC power.	No		Retain for Phase II analysis.
17	Install a steam-driven turbine generator that uses reactor steam and exhausts to the suppression pool.	Increased availability of on-site AC power.	No		Retain for Phase II analysis.
27	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	No		Retain for Phase II analysis.
28	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	No		Retain for Phase II analysis.
35	Add signals to open safety relief valves automatically in an MSIV closure transient.	Reduced likelihood of SRV failure to open in an MSIV closure transient reduces the probability of a medium LOCA.	No		Retain for Phase II analysis. Open reliably now.
39	Increase flow rate of suppression pool cooling.	Improved suppression pool cooling.	No		Retain for Phase II analysis. Do not need more flow, backup is better solution. See item 75.
41	Provide capability for alternate injection via reactor water cleanup (RWCU).	Improved injection capability.	No		Retain for Phase II analysis. No connections.
49	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high-and low-pressure safety injection systems.	No		Retain for Phase II analysis.
52	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	No		Retain for Phase II analysis. Core spray now cooled by ESW.

Table 6-1 DAEC Phase I SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
55	Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers.	Improved ability to cool RHR heat exchangers.	No		Retain for Phase II analysis.
56	Add a service water pump.	Increased availability of cooling water.	No		Retain for Phase II analysis.
75	Install an independent method of suppression pool cooling.	Increased availability of containment heat removal.	No		Retain for Phase II analysis.
78	Enable flooding of the drywell head seal.	Reduced probability of leakage through the drywell head seal.	No		Retain for Phase II analysis.
107	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	No		Retain for Phase II analysis.
117	Increase boron concentration or enrichment in the SLC system.	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	No		Retain for Phase II analysis.
120	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	No		Retain for Phase II analysis.
123	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	No		Retain for Phase II analysis.
139	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	No		Retain for Phase II analysis.
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.	No		Retain for Phase II analysis.
163	Improve the reliability of the RWS system control valves CV4914 and CV4915.	Decreased risk due to failures of the RWS system. (High PRA importance list.)	No		Retain for Phase II analysis.
164	Improve the reliability of the RWS control system.	Decreased risk due to failures of the RWS system. (High PRA importance list - HS-4914.)	No		Retain for Phase II analysis.
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)	No		Retain for Phase II analysis.

7 PHASE II SAMA ANALYSIS

A cost-benefit analysis was performed on each of the SAMA candidates remaining after the Phase I screening. The benefit of a SAMA candidate is the difference between the baseline cost of severe accident risk (maximum benefit from Section 4.5) and the cost of the severe accident risk with the SAMA implemented (Section 7.1). The cost figure used is the estimated cost to implement the specific SAMA. If the benefit exceeds the estimated cost of implementation the SAMA is cost-beneficial.

7.1 SAMA BENEFIT

7.1.1 Severe Accident Risk With SAMA Implemented

Bounding analyses were used to determine the change in risk following implementation of SAMA candidates or groups of similar SAMA candidates. For each analysis case, the Level 1 internal events or Level 2 PRA models were altered to conservatively consider implementation of the SAMA candidate(s). Then, severe accident risk measures were calculated using the same procedure used for the baseline case described in Section 3.

The severe accident risk measures were obtained for each analysis case by modifying the baseline model in a simple manner to capture the effect of implementation of the SAMA in a bounding manner. Bounding analyses are very conservative and result in overestimation of the benefit of the candidate analyzed. However, if this bounding assessment yields a benefit that is smaller than the cost of implementation, then the effort involved in refining the PRA modeling approach for the SAMA would be unnecessary because it would only yield a lower benefit result. If the benefit is greater than the cost when modeled in this bounding approach, it is necessary to refine the PRA model of the SAMA to remove conservatism. As a result of this modeling approach, models representing the Phase II SAMAs will not all be at the same level of detail and if any are implemented, the PRA result after implementation of the final installed design will differ from the screening-type analyses done during this evaluation.

Examples of hypothetical “bounding analyses” are:

> ***LBLOCA***
> *This analysis case was used to evaluate the change in plant risk profile that would be achieved if a digital large break LOCA protection system was installed. Although the proposed change would not completely eliminate the potential for a large break LOCA, a bounding benefit was estimated by removing the large break LOCA initiating event. This analysis case was used to model the benefit of SAMA xx.*
>
> ***DCPWR***

This analysis case was used to evaluate plant modifications that would increase the availability of Class 1E DC power (e.g., increased battery capacity or the installation of a diesel-powered generator that would effectively increase battery capacity). Although the proposed SAMAs would not completely eliminate the potential failure, a bounding benefit was estimated by removing the battery discharge events and battery failure events. This analysis case was used to model the benefit of SAMAs a, b, etc.

7.1.2 Cost of Severe Accident Risk with SAMA Implemented

Using the PRA analyses described in Section 7.1.1, severe accident impacts in four areas (off-site exposure cost, off-site economic cost, on-site exposure cost, and on-site economic cost) were calculated using the same procedure used for the baseline case described in Section 4. As in Section 4.5, the severe accident impacts were summed to estimate the total cost of severe accident risk with the SAMA implemented.

7.1.3 SAMA Benefit

The respective SAMA benefit was calculated by subtracting the total cost of severe accident risk with the SAMA implemented from the baseline cost of severe accident risk (maximum benefit from Section 4.5). The estimated benefit for each SAMA candidate is listed in Table 7.1.3-1. The calculation of the benefit is performed using an Excel spreadsheet.

7.2 COST OF SAMA IMPLEMENTATION

The final step in the evaluation of the SAMAs is estimating the cost of implementation for comparison with the benefit. For the purpose of this analysis, the DAEC staff has estimated that the cost of making a change to a procedure and for conducting the necessary training on a procedure change is expected to exceed $30,000. Similarly, the minimum cost associated with development and implementation of an integrated hardware modification package (including post-implementation costs, e.g. training) was assumed to be $100,000. These values were used for comparison with the benefit of SAMAs.

The benefits resulting from the bounding estimates presented in the benefit analysis are in some cases rather low. In those cases for which the benefits are so low that it is obvious that the implementation costs would exceed the benefit, a detailed cost estimate was not warranted. In those cases where the benefit exceeded the minimum implementation costs, the SAMA was further assessed by an expert panel.

Table 7.1.3-1 DAEC Phase II SAMA Analysis

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
10	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	37.79%	41.43%	NOSBO	This case determines the benefit of eliminating all Station Blackout events. This allows evaluation of possible improvements related to SBO sequences. For the purposes of the analysis, a single bounding analysis is performed which assumes the standby diesel generators do not fail.	$954K	>MAB	Expert Panel.	Not Cost-Beneficial	Cost exceeds MAB.
12	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	12.38%	18.18%	NOSBO2A	This case was used to determine the benefit of installing a cross-tie between the two 4160V busses. For the purposes of the analysis, a single bounding analysis was performed which assumed the Div. I diesel generator does not fail. The Div. I diesel generator was chosen since it has higher risk reduction worth than the Div. II diesel generator	$399K	>$1,000K	Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit.
15	Install a gas turbine generator.	Increased availability of on-site AC power.	37.79%	41.43%	NOSBO	This case determines the benefit of eliminating all Station Blackout events. This allows evaluation of possible improvements related to SBO sequences. For the purposes of the analysis, a single bounding analysis is performed which assumes the standby diesel generators do not fail.	$954K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB

Table 7.1.3-1 DAEC Phase II SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
17	Install a steam-driven turbine generator that uses reactor steam and exhausts to the suppression pool.	Increased availability of on-site AC power.	37.79%	41.43%	NOSBO	This case determines the benefit of eliminating all Station Blackout events. This allows evaluation of possible improvements related to SBO sequences. For the purposes of the analysis, a single bounding analysis is performed which assumes the standby diesel generators do not fail.	$954K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
27	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	26.16%	26.08%	LOCA03	This case determines the impact of eliminating the small, medium, and large LOCA initiators, the break outside of containment initiator, the inadvertent open relief valve initiator, and stuck open relief valve sequences in the quantification of the PRA model.	$570K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
28	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	37.21%	35.99%	LOCA01	This case determines the benefit of the HPCI system operating without failure. For the purposes of the analysis, a single bounding analysis is performed which assumes the HPCI system does not fail.	$814K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
35	Add signals to open safety relief valves automatically in an MSIV closure transient.	Reduced likelihood of SRV failure to open in an MSIV closure transient reduces the probability of a medium LOCA.	15.12%	7.64%	SRV01	This case determines the benefit of safety/relief valves successfully opening without failure. For the purposes of the analysis, a single bounding analysis is performed which assumes the safety/relief valves do not fail to open when demanded.	$185K	>1,000K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit.

Table 7.1.3-1 DAEC Phase II SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
39	Increase flow rate of suppression pool cooling.	Improved suppression pool cooling.	8.14%	8.36%	CONT01	This case determines the benefit of eliminating all containment heat removal failures. For the purpose of the analysis, a single bounding analysis is performed which assumes the event tree node representing torus cooling is always successful.	$167K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
41	Provide capability for alternate injection via reactor water cleanup (RWCU).	Improved injection capability.	16.28%	15.96%	LOCA04	Eliminate all steam line breaks and stuck open SRVs. This will be used to evaluate using RWCU for vessel injection. RWCU injection will only be effective for LOCAs that represent a steam break.	$345K	$1,300K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
49	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and low-pressure safety injection systems.	26.16%	26.08%	LOCA03	This case determines the impact of eliminating the small, medium, and large LOCA initiators, the break outside of containment initiator, the inadvertent open relief valve initiator, and stuck open relief valve sequences in the quantification of the PRA model.	$570K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
52	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	26.16%	26.08%	LOCA03	This case determines the impact of eliminating the small, medium, and large LOCA initiators, the break outside of containment initiator, the inadvertent open relief valve initiator, and stuck open relief valve sequences in the quantification of the PRA model.	$570K	>$1,500K	Per Expert Panel. $700K per motor x 2, engineering costs, plus installation	Not Cost-Beneficial	Cost Exceeds Benefit.

Table 7.1.3-1 DAEC Phase II SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
55	Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers.	Improved ability to cool RHR heat exchangers.	4.65%	8.65%	SW01	This case determines the benefit of the RHR Service Water system operating without failure. For the purposes of the analysis, a single bounding analysis is performed which assumes the RHR Service Water system does not fail.	$156K	>$500K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
56	Add a service water pump.	Increased availability of cooling water.	4.65%	8.65%	SW01	This case determines the benefit of the RHR Service Water system operating without failure. For the purposes of the analysis, a single bounding analysis is performed which assumes the RHR Service Water system does not fail.	$156K	>$1,000K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
75	Install an independent method of suppression pool cooling.	Increased availability of containment heat removal.	8.14%	8.36%	CONT01	This case determines the benefit of eliminating all containment heat removal failures. For the purpose of the analysis, a single bounding analysis is performed which assumes the event tree node representing torus cooling is always successful.	$167K	>$1,000K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
78	Enable flooding of the drywell head seal.	Reduced probability of leakage through the drywell head seal.	0.00%	1.77%	CONT02B	Eliminate all failures of the drywell head flange seal.	$26K	>$100K	Expert Panel Procedure, does not consider ability to access area.	Not Cost-Beneficial	Cost Exceeds Benefit
107	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	0.58%	0.52%	ISLOCA	This case determines the impact of eliminating all Interfacing System LOCA initiated sequences in the quantification of the PRA model.	$10.5K	>MAB	Per Expert Panel. Plant must be shutdown in order to test.	Not Cost-Beneficial	Cost Exceeds MAB. All ISLOCA paths have pressure monitoring instrumentati on.

Table 7.1.3-1 DAEC Phase II SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
117	Increase boron concentration or enrichment in the SLC system.	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	6.60%	6.00%	ATWS02	Eliminate all failures of SLC to inject. In other words, successful boron injection in ATWS scenarios.	137K	$400K	Expert Panel	Not Cost-Beneficial	.Cost Exceeds Benefit
120	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	29.65%	25.63%	NOATWS	This case determines the benefit of eliminating all ATWS events. For the purposes of the analysis, a single bounding analysis is performed which assumes that ATWS events do not occur.	$590K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
123	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	29.65%	25.63%	NOATWS	This case determines the benefit of eliminating all ATWS events. For the purposes of the analysis, a single bounding analysis is performed which assumes that ATWS events do not occur.	$590K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
139	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	26.16%	26.08%	LOCA03	This case determines the impact of eliminating the small, medium, and large LOCA initiators, the break outside of containment initiator, the inadvertent open relief valve initiator, and stuck open relief valve sequences in the quantification of the PRA model.	$570K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB

Table 7.1.3-1 DAEC Phase II SAMA Analysis (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	Cost Basis	Evaluation	Basis for Evaluation
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.	12.79%	14.62%	RWS01	Eliminate all failures of the RWS system.	$320K	$250K	Per Expert Panel. Add a T-connection and valve to the pipe connecting the RHRSW/ESW pit to the Circ Water pit to allow for backflow from the Circ Water pit to the RHRSW/ESW pit.	Potentially Cost-Beneficial	Potentially Cost-Beneficial
163	Improve the reliability of the RWS system control valves CV4914 and CV4915.	Decreased risk due to failures of the RWS system. (High PRA importance list.)	12.79%	14.62%	RWS01	Eliminate all failures of the RWS system.	$320K	>$1,000K	Per Expert Panel. Add a parallel path with piping and valve to each loop.	Not Cost-Beneficial	Cost Exceeds Benefit
164	Improve the reliability of the RWS control system.	Decreased risk due to failures of the RWS system. (High PRA importance list - HS- 4914.)	0.37%	0.49%	RWS02 Vs BASE02	Eliminate all failures of RWS handswitch HS-4914 and the corresponding switch in the opposite loop.	$10.0K	$100K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit.
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)	6.40%	13.20%	LOCA05	Eliminate all failures of the low pressure ECCS low reactor pressure permissive pressure switches.	$276K	$250K	Per Expert Panel, for jumpers in control panel covered by procedure.	Potentially Cost-Beneficial	Potentially Cost Beneficial.

8 SENSITIVITY ANALYSES

The purpose of performing sensitivity analyses is to examine the impact of analysis assumptions on the results of the SAMA evaluation. This section identifies several sensitivities that can be performed during SAMA (NEI 2005) and discusses the sensitivity as it applies to DAEC including the impact of the sensitivity on the results of the Phase II SAMA analysis at DAEC.

Unless it was otherwise noted, it is assumed in these sensitivity analyses that sufficient margin existed in the maximum benefit estimation that the Phase I screening would not have to be repeated in the sensitivity analyses.

8.1 PLANT MODIFICATIONS

There are no plant modifications that are currently pending that would be expected to impact the results of this SAMA evaluation.

8.2 UNCERTAINTY

Since the inputs to PRA cannot be known with complete certainty, there is possibility that the actual plant risk is greater than the mean values used in the evaluation of the SAMA described in the previous sections. To consider this uncertainty, a sensitivity analysis was performed in which an uncertainty factor was applied to the frequencies calculated by the PRA. Upper bound benefits were calculated based upon the mean risk values multiplied by this uncertainty factor. A value of 2.5 was used for the uncertainty factor and was based on a review of similar PRAs (FPL 2007a). Table 8.2-1 provides the benefit results from each of the sensitivities for each of the SAMA cases evaluated.

Two SAMAs (12 and 78) have upper bound benefits that exceed the costs of implementation. These two SAMAs have been retained as potentially cost-beneficial.

8.3 PEER REVIEW FACTS/OBSERVATIONS

The model used in this SAMA analysis includes the resolution (Section 3.3) of the Facts-and-Observations identified during the PRA Peer Review. Therefore, no specific sensitivities were performed related to this issue.

8.4 LEVEL 3 SENSITIVITIES

Perturbations to some MACCS2 inputs were investigated to determine their effects on annual risk. Among the parameters analyzed, release height, release heat, evacuation time and speed, general emergency declaration time and meteorological data year have been discussed previously. The effect of building wake on the risk was determined because the proximity of other site buildings to the DAEC containment introduces uncertainty as to local air flow around these buildings.

Severe meteorological conditions in the last spatial segment of the model domain (40-50 miles) were chosen to assure conservatively high impacts and risks. Most especially, perpetual rainfall was imposed on this segment so that a conservatively large quantity of the nuclides released in each scenario were deposited (via wet deposition) within the model domain.

Table 8.4-1 gives the sensitivity of the risk to the choice of these parameters. The table also discusses the reason for considering that parameter and the result. Other than imposing the above described meteorological condition on the 40-50 mile distance interval and the choice of meteorological data year, the site risks to severe accidents vary no more than 3% as a result of any of the considered parameter changes. The baseline modeling conservatisms of specifying rainfall in the spatial ring from 40-50 miles and the choice of severe meteorological year is seen to more than balance any increases that might be due to alternative specification of release parameters.

8.5 DISCOUNT RATE

Calculation of severe accident impacts in the DAEC SAMA analysis was performed using a “real discount rate” of 7% (0.07/year) as recommended in NUREG/BR-0184 (NRC 1997).. Use of both a 7% and 3% real discount rate in regulatory analysis is specified in Office of Management Budget guidance (OMB 2003) and in NUREG/BR-0058 (NRC 2004). Therefore, a sensitivity analysis was performed using a 3% real discount rate.

In this sensitivity analysis, the real discount rate in the Level 3 PRA model was changed to 3% from 7% and the Phase II analysis was re-performed with the lower interest rate. Similarly, an additional sensitivity analysis was performed where the discount rate was changed to 8.5% from 7% and the Phase II analysis was re-preformed. The 8.5% discount rate is currently used by FPL-Energy for project cost estimating.

The results of this sensitivity analysis are presented in Table 8.2-1. Neither sensitivity analysis challenges any decisions made regarding the SAMAs.

8.6 ANALYSIS PERIOD

As described in Section 4, calculation of severe accident impacts involves an analysis period term, t_f, which could have been defined as either the period of extended operation (20 years), or the years remaining until the end of facility life (from the time of the SAMA analysis to the end of the period of extended operation). Based on the current license expiration date of February 21, 2014, that time period is 27 years.

The value used for this term was the period of extended operation (20 years).

In this sensitivity analysis, the analysis period was modified to 27 years and the Phase II analysis was re-performed.

The results of this sensitivity analysis are presented in Table 8.2-1. This sensitivity analysis does not challenge any decisions made regarding the SAMAs.

Table 8.2-1 DAEC Sensitivity Evaluation

DAEC SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at BE Disc Rate	Benefit at 27yrs	Benefit at UB	Cost	Cost Basis	Evaluation	Basis for Evaluation
10	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	NOSBO	$954K	$1,376K	$850K	$1,093K	$2,386K	>$5,000 K	Expert Panel.	Not Cost-Beneficial	Cost Exceeds Benefit
12	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	NOSBO2A	$399K	$572K	$354K	$456K	$998K	>$1,000 K	Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
15	Install a gas turbine generator.	Increased availability of on-site AC power.	NOSBO	$954K	$1,376K	$805K	$1,093K	$2,386K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB
17	Install a steam-driven turbine generator that uses reactor steam and exhausts to the suppression pool.	Increased availability of on-site AC power.	NOSBO	$954K	$1,376K	$850K	$1,093K	$2,386K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
27	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	LOCA03	$570K	$826K	$508K	$655K	$1,426K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
28	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	LOCA01	$814K	$1,179K	$725K	$935K	$2,035K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
35	Add signals to open safety relief valves automatically in an MSIV closure transient.	Reduced likelihood of SRV failure to open in an MSIV closure transient reduces the probability of a medium LOCA.	SRV01	$185K	$275K	$164K	$215K	$462K	>1,000K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
39	Increase flow rate of suppression pool cooling.	Improved suppression pool cooling.	CONT01	$167K	$242K	$149K	$192K	$418K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
41	Provide capability for alternate injection via reactor water cleanup (RWCU).	Improved injection capability.	LOCA04	$345K	$499K	$307K	$396K	$861K	$1,300K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
49	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high-and low-pressure safety injection systems.	LOCA03	$570K	$826K	$508K	$655K	$1,426K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
52	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	LOCA03	$570K	$826K	$508K	$655K	$1,426K	>$1,500 K	Per Expert Panel. $700K per motor x 2, engineering costs, plus installation	Not Cost-Beneficial	Cost Exceeds Benefit .
55	Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers.	Improved ability to cool RHR heat exchangers.	SW01	$156K	$224K	$139K	$178K	$391K	>$500K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
56	Add a service water pump.	Increased availability of cooling water.	SW01	$156K	$224K	$139K	$178K	$391K	>$1,000 K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
75	Install an independent method of suppression pool cooling.	Increased availability of containment heat removal.	CONT01	$167K	$242K	$149K	$192K	$418K	>$1,000 K	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit
78	Enable flooding of the drywell head seal.	Reduced probability of leakage through the drywell head seal.	CONT02B	$26K	$36K	$23K	$29K	$65K	>$100K	Expert Panel, for procedure, does not consider ability to access area.	Not Cost-Beneficial	Cost exceeds benefit.

Table 8.2-1 DAEC Sensitivity Evaluation (Cont.)

DAEC SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at BE Disc Rate	Benefit at 27yrs	Benefit at UB	Cost	Cost Basis	Evaluation	Basis for Evaluation
107	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	ISLOCA	$10.5K	$14.9K	$9.3K	$11.9K	$26.1K	>MAB	Per Expert Panel. Plant must be shutdown in order to test.	Not Cost-Beneficial	Cost Exceeds MAB. All ISLOCA paths have pressure monitoring instrumentation.
117	Increase boron concentration or enrichment in the SLC system.	Reduced time required to achieve shutdown concentration provides increased margin in the accident timeline for successful initiation of SLC.	ATWS02	$137K	$198K	$122K	$157K	$342K	$400K	Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
120	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	NOATWS	$590K	$857K	$525K	$678K	$1,474K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
123	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	NOATWS	$590K	$857K	$525K	$678K	$1,474K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
139	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	LOCA03	$570K	$826K	$508K	$655K	$1,426K	>MAB	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds MAB.
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.	RWS01	$320K	$461K	$285K	$366K	$800K	$250k	Per Expert Panel. Add a T-connection and valve to the pipe connecting the RHRSW/ESW pit to the Circ Water pit to allow for backflow from the Circ Water pit to the RHRSW/ESW pit.	Potentially Cost-Beneficial	Potentially Cost-Beneficial
163	Improve the reliability of the RWS system control valves CV4914 and CV4915.	Decreased risk due to failures of the RWS system. (High PRA importance list.)	RWS01 Vs BASE02	$320K	$461K	$285K	$366K	$800K	>$1,000 K	Per Expert Panel. Add a parallel path with piping and valve to each loop.	Not Cost-Beneficial	Cost Exceeds Benefit .
164	Improve the reliability of the RWS control system.	Decreased risk due to failures of the RWS system. (High PRA importance list - HS- 4914.)	RWS02b2	$10.0K	$14.4K	$8.9K	$11.5K	$25.1K	$100k	Per Expert Panel	Not Cost-Beneficial	Cost Exceeds Benefit .
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)	LOCA05	$276K	$393K	$246K	$314K	$690K	$250	Per Expert Panel, for jumpers in control panel covered by procedure.	Potentially Cost-Beneficial	Potentially Cost Beneficial.

Note: The benefits in this table are provided for 5 cases: (1) “Benefit” – Baseline benefit calculated using nominal values for all parameters; (2) “Benefit at 3% Disc Rate” – Benefit calculated using 3% discount rate rather than the nominal 7%; (3) “Benefit at BE Disc Rate” – Benefit calculated using the best estimate discount rate of 8.5% provided by DAEC rather than the nominal 7%; (4) “Benefit at 27yrs” – Benefit using a 27-year calculation period rather than the nominal 20 years; and (4) “Benefit at UB” – Benefit calculated using the upperbound of CDF as defined by DAEC rather than the point estimate for CDF.

Table 8.4-1. Sensitivity of DAEC Baseline Risk (Dose/Economic) to Parameter Changes

Parameter	Input Discussion	Ratio to 50-Mile Baseline Population Dose/Cost Risk	Output Discussion
Number of Samples per Weather Bin	The baseline mean risk is determined by sampling each hour of each day of the baseline year (see Annual Met Data Set next). The many sensitivity studies use the more rapidly executed weather bin sampling method to approximate the mean risk.	4 samples/weather bin: Dose = 92% Cost = 91% 8 samples/weather bin: Dose = 101% Cost = 103%	8 samples per weather bin more closely approximate the true mean risk (i.e., sampling each hour of each day) than does 4 samples per weather bin. All sensitivity runs use 8 samples per weather bin. All subsequent sensitivity ratios are to the baseline risk calculated with 8 samples per weather bin.
Annual Met Data Set	Each year 2002-2006	Dose = 85% (2004) to 97% (2006) Cost = 84% (2004) to 97% (2006)	2005, maximum risk year, chosen as baseline. Mean baseline risk (see MACCS2 Results Section) samples each hour of each day.
2000 Evacuation Speed	Baseline updated 2000 study with 2040 population, assumed EPZ roads at saturation in former.	Dose = 99% Cost = No change[2]	Faster 2000 evacuation speed does not significantly change risk. 0-10 mile risk is minor contributor to 50-mile risk.
95% of population evacuating as indicator of period from emergency declaration until evacuation begins	Baseline considered 50% of population evacuating as indicator.	No change	0-10 mile risk is minor contributor to 50-mile risk.
General emergency declaration at time zero	Baseline assumed declaration at later time of core damage.	Dose = 98% Cost = No change	Sooner start of evacuation results in minor decrease in dose risk. Choice of core damage time is conservative. 0-10 mile risk is minor contributor to 50-mile risk.
Release Height	Baseline assumed release from top of reactor building for all but M/I and M/E release categories. Variation in the top of building release heights are considered here.	Release at 100 feet above grade: Dose = No change Cost = 99% Ground-level release: Dose = No change Cost = 99%	Decrease in release height increases close-in deposition. Change negligible but top of reactor building release is conservative.
Release Heat (1 MW per segment)	Baseline assumed no heat. Up to 4 segments released per scenario.	Dose= No change Cost = 101%	Effect of buoyant plume rise is similar to increase in release height.
Release Heat (10 MW per segment)	Baseline assumed no heat. Large value to bound effects.	Dose= No change Cost = No change	See release height notes above.
Wake Effects, SIGYINIT, SIGZINIT	Baseline determined based on reactor building size. Uncertainty due to proximity of other buildings.	One-half baseline: Dose = No change Cost = No change Two times baseline: Dose = No change Cost = 99%	Minor changes very near release.
Meteorology specification in last spatial segment, LIMSPA	Rainfall imposed at all times from 40 to 50 miles from release to force conservative population exposure in baseline case.	Dose = 91% Cost = 85%	Entire decrease is due to removing perpetual rainfall (wet deposition) and specifying measured meteorology in ring from 40 to 50 miles from site.

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[2] No Change indicates <0.5% change in risk

9 CONCLUSIONS

As a result of this analysis, the SAMAs identified in Table 9-1 have been identified as potentially cost beneficial, either directly or as a result of the sensitivity analyses. These SAMAs are not aging-related and are therefore not required to be resolved as part of the relicensing effort. However, since these potential improvements could result in a reduction in public risk, these SAMAs have been entered into the DAEC long-range plan development process for further consideration.

Implementation of SAMA 156 would involve the addition of a T-connection and valve to the pipe connecting the RHRSW/ESW pit to the Circ Water pit to allow for backflow from the Circ Water pit to the RHRSW/ESW pit. This would improve the reliability of the RHRSW/ESW system through addition of a redundant water source.

Implementation of SAMA 166 would involve panel modifications to allow bypass of failed ECCS reactor low pressure permissive signals and develop emergency procedures for installation of the low reactor pressure permissive bypass. This would improve the reliability of the low pressure ECCS systems given a failure of the low reactor pressure permissive signals which was identified as a top risk contributor from the PRA model.

Table 9-1 DAEC Potentially Cost Beneficial SAMAs

DAEC SAMA Number	Potential Improvement	Discussion
156	Provide an alternate source of water for the RHRSW/ESW pit.	Decrease the contribution to risk due to failure of the RWS system.
166	Increase the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Install manual bypass of low pressure permissive.	Decreased risk due to failures of the low pressure ECCS systems. (High PRA importance list.)

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