NUREG-1484
Vol. 1

Final Environmental Impact Statement for the Construction and Operation of Claiborne Enrichment Center, Homer, Louisiana

Environmental Impact Statement

Docket No. 70-3070
Louisiana Energy Services, L.P.

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

August 1994

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ABSTRACT

This two-volume Final Environmental Impact Statement (FEIS) was prepared by the Nuclear Regulatory Commission (NRC) in accordance with regulation 10 CFR Part 51, which implements the National Environmental Policy Act (NEPA). Volume 1 contains the assessment of the potential environmental impacts for licensing the construction and operation of a proposed gaseous centrifuge enrichment facility to be built in Claiborne Parish, Louisiana, by Louisiana Energy Services, L.P. (LES). The proposed facility would have a production capacity of about 866 metric tons annually of up to 5 weight percent enriched UF_6, using a proven centrifuge technology. Included in the assessment are construction, both normal operations and potential accidents (internal and external events), and the eventual decontamination and decommissioning (D&D) of the site. Issues addressed include the purpose and need for the facility, the alternatives to the proposed action, potential disposition of the tails, the site selection process, and environmental justice. The NRC staff concludes that the facility can be constructed and operated with small and acceptable impacts on the public and the environment. The FEIS supports issuance of a license to the applicant, Louisiana Energy Services, to authorize construction and operation of the proposed facility.

Volume 2 of the FEIS contains Appendix B, Public Comments and NRC Response, which provides copies of all letters received from agencies and the public commenting on the Draft Environmental Impact Statement (DEIS) issued in November 1993. Appendix B also includes NRC responses to the comments.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY AND CONCLUSIONS

Introduction:

This Environmental Impact Statement (EIS) was prepared by the U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Material Safety and Safeguards to assess the potential environmental impacts of licensing the construction and operation of a uranium enrichment facility to be located in Claiborne Parish, Louisiana (the proposed action). The proposed facility will use the centrifuge enrichment process, which is an energy-efficient, proven advanced technology.

The facility, Claiborne Enrichment Center (CEC), will be owned and operated by Louisiana Energy Services, L.P. (LES), which is a Delaware limited partnership company. The EIS was prepared in accordance with NRC regulation 10 CFR Part 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA), as amended. The EIS analyzes the potential environmental impacts of the proposed action and eventual decontamination and decommissioning (D&D) of the facility, and discusses the effluent and environmental monitoring programs proposed to assess the potential environmental impacts of facility construction and operation. The EIS also considers a no-action alternative.

Proposed Action:

The proposed action is to license the construction and operation of a uranium enrichment facility at the CEC near Homer, Louisiana, which will use the gas centrifuge process to separate natural uranium hexafluoride feed material containing 0.71 weight percent ^{235}U into a product stream enriched up to 5.0 weight percent ^{235}U and a tails stream containing approximately 0.2 to 0.34 weight percent ^{235}U. Production capacity at design throughput is approximately 1.5 million separative work units (SWU) per year. Facility construction is expected to require 6 years. Construction would be conducted in three phases. Operation would commence after the completion of the first 0.5 million SWU capacity phase. The facility is designed for 30 years of operation. D&D is projected to take 7 years.

LES estimates the cost of the plant, including interest, property tax, and transmission facilities to be approximately $855 million. Escalation, capitalized interest, contingency, tails disposal, decommissioning, and replacement centrifuges raise the total investment to about $1.6 billion. Revenue from SWU sales is estimated at $165 million/year. All values are expressed in 1990 dollars.

Need for the Proposed Action:

LES estimates that the proposed facility production represents about 17 percent of the estimated U.S. requirement for enrichment services in the year 2000. LES also estimates that approximately 70 percent of the U.S. demand for enrichment services in 2000 is

uncommitted. Accordingly, LES considers that the CEC would be a complementary and competitive supplier for this service and would provide a means to offset both foreign enrichment supplies and the more energy-intensive production from U.S. gaseous diffusion plants.

The impacts discussed in this EIS assume that the plant will be built and operated. It should be noted that the enrichment market in the future will continue to be highly competitive. In particular, in May 1993, the U.S. and Russia reached an agreement on the blending of Russian highly-enriched uranium (HEU) to low-enriched uranium (LEU) and its sale to the U.S. Under the agreement, Russia will supply LEU with the equivalent of 92.1 million SWUs over the 1994-2013 period. Approximately 5.53 million SWUs per year will be supplied in the 1999-2013 period. Although the exact timing and impacts of the Russian supplies and other potential competition are uncertain, they are likely to result in downward pressure on U.S. and world SWU prices. The potential price-depressing effect of the Russian LEU introduces additional uncertainty concerning the economic feasibility of the CEC in the proposed time period. If the plant operates at substantially reduced capacity, the associated economic benefits will be reduced.

No-Action Alternative:

The no-action alternative is denial of the license application for the facility, in which case the proposed site is assumed to revert to its former use.

Environmentally, the likely continuation of logging at the same rate as before would allow a continuation of soil erosion, surface water contamination, and an imbalance of biological diversity.

The local socioeconomic impact of the no-action alternative is a continuation of the depressed economic conditions in the area and a likely continued outmigration of skilled and higher income workers. State-wide, the impact of the no-action alternative is the failure to obtain a minimum of 450 jobs per year during construction and 600 per year during full operations (annual averages, including multiplied effects).

Nationally, the impacts of the no-action alternative are: (1) no change in the pressure on other enrichment suppliers to maintain a competitive position in the world enrichment market; (2) loss of an additional domestic supplier to reduce potential dependence on foreign sources; and (3) loss of the opportunity to substitute an energy-efficient process for the older gaseous diffusion process.

Environmental Impacts of Construction:

The construction of the CEC involves the clearing of 28 hectares (70 acres) of recently cut wooded area within a 179-hectare (442-acre) site. These 28 hectares will be graded and will form the controlled access area. Several environmental protection measures will be taken

to mitigate potential construction impacts. The measures will include controls for noise, erosion and slumping, oil and hazardous material spills, and dust.

The potential impacts associated with the construction phase of CEC are primarily limited to surface and groundwater resources at the site. The grading activities may affect the surface water runoff direction and flow rate. Surface water runoff will be directed to the Hold-Up Basin which is designed to prevent offsite migration of eroded soil to Lake Avalyn and Bluegill Pond. It is estimated that about 20 percent of the total current annual surface water discharge to Lake Avalyn will be diverted to Bluegill Pond. Total suspended solids (TSS) in the Hold-Up Basin effluents should not exceed 20.8 mg/L. This level is less than half of the Louisiana Department of Environmental Quality (LDEQ) standard for TSS. Construction may also locally affect the recharge rate of the shallow aquifer directly beneath the site by reducing infiltration of precipitation. Reduction of groundwater recharge will have effects on the site hydrology, which will be local to the site and very small. Impacts of fugitive dust and emissions are also local and are not expected to significantly impact air quality beyond the immediate area during construction.

Potential spills of oil and other hazardous substances are unlikely to impact the environment, since only small quantities of these substances will be used or stored onsite. The construction phase impacts on air quality, land use, transportation, and socioeconomics are localized, temporary, and small. The temporary influx of labor is not expected to overload community services and facilities, except possibly public safety. Construction of the CEC is expected to have generally positive socioeconomic impacts on the region. No radioactive releases (other than natural radioactive materials, for example in soil) will result from site development and facility construction activities.

Environmental Impacts of Operation:

The CEC design was influenced by several local environmental factors in order to ensure operational safety. The CEC is designed to ensure minimal impact on buildings from severe weather (heavy rainfall and cyclonic winds) and seismic events.

Operation of the CEC would result in the production of gaseous, liquid, and solid waste streams. Each stream could contain small amounts of hazardous and radioactive compounds either alone or in a mixed form. Routine uranium releases to the atmosphere are estimated to be 4.4 million Bq (120 μCi) annually. Radioactive releases will be at an elevation of about 36.6 meters (120 feet) through one of the three stacks north of the Separations Building.

Liquid effluents include stormwater runoff, treated sanitary and industrial wastewater, and treated radiologically contaminated wastewater. All liquid effluents, with the exception of stormwater, go through Outfall 001 after treatment. Stormwater releases are routed without treatment to the Hold-Up Basin and are released to Bluegill Pond at Outfall 002. These outfalls will be regulated by a National Pollutant Discharge Elimination System (NPDES)

Permit and a Louisiana Water Discharge System Permit. Approximately 380,000 m^3 of stormwater is expected to be released annually to Bluegill Pond. In addition, it is estimated that approximately 9,500 m^3 of treated effluents will be discharged annually. Uranium is the only radioactive contaminant expected to be released in the liquid effluent. The source term for liquid releases is estimated to be at 1 million Bq (28 μCi) per year.

Solid waste that would be generated at CEC is grouped into nonhazardous, radioactive, hazardous, and mixed waste categories. All these wastes will be collected and transferred to authorized treatment or disposal facilities offsite.

All solid radioactive waste generated is Class A low-level waste as defined in 10 CFR Part 61. This waste consists of industrial waste, filters and filter material, resins, gloves, shoe covers, and laboratory waste. Approximately 1,100 kg of low-level waste would be generated annually. In addition, annual hazardous and mixed wastes generated at CEC are expected to be about 650 kg and 460 kg, respectively. These wastes will be collected, inspected, volume-reduced, and transferred to treatment facilities or disposed of at authorized waste disposal facilities. Operation of the CEC would also result in the annual production of approximately 3,800 metric tons of depleted UF_6 (DUF_6) tails. The DUF_6 would be stored onsite in cylinders, and would have small impact while in storage. The removal and disposition of DUF_6 may involve its conversion offsite to U_3O_8. The removal of DUF_6 from the site will commence within 15 years of initiating enrichment or after production of no more than 80,000 metric tons of DUF_6, whichever occurs first.

The assessment of potential impact considers the entire population surrounding the proposed CEC within a distance of 80 kilometers (50 miles). The three individuals whose exposure would bound potential impacts were assumed to be located 800 meters north of the plant stacks at a permanent residence, 570 meters south-southeast of the plant stacks at the edge of Bluegill Pond, and 6,500 meters south of the plant stacks at the northern edge of Lake Claiborne. The atmospheric dispersion modeling predicted that the maximum annual average air concentrations of radioactive and nonradioactive material releases would occur approximately 800 meters north of the plant stacks. Annual average air concentrations for the Bluegill Pond and nearest resident locations are approximately 20 percent less than the maximum values.

Radiological Impacts:

Radiological impacts are regulated by the new NRC 10 CFR Part 20 which specifies a total effective dose equivalent (TEDE) limit for members of the public of 1 mSv/yr (100 mrem/yr) from all sources and pathways from CEC excluding natural background sources. Further, CEC would be subject to the Environmental Protection Agency's (EPA's) applicable standards in 40 CFR Part 190 which require that doses under routine operations should not exceed 0.25 mSv to the whole body, 0.75 mSv to the thyroid, and 0.25 mSv to any other organ from all pathways; and EPA's standards in 40 CFR Part 61 Subpart I which

require that no member of the public receive an effective dose equivalent in excess of 0.1 mSv (10 mrem/yr) due to atmospheric releases.

Potential radiological impacts from operation of the CEC would result from controlled releases of small quantities of UF_6 during normal operations and releases of UF_6 under hypothetical accident conditions. Normal operational release rates to the atmosphere and surface waters are expected to be less than $4.4\times10^{+6}$ Bq/yr (120 μCi/yr) and $1.0\times10^{+6}$ Bq/yr (28 μCi/yr), respectively. Estimated committed effective annual dose equivalent (CEDE) to the maximally exposed adult individual due to atmospheric releases is 8.0×10^{-10} Sv (8.0×10^{-8} rem), while annual population doses are estimated as 3.0×10^{-6} person-Sv (3.0×10^{-4} person-rem). Atmospheric pathway dose to the critical individual, an infant located at the 800 meter residence, is estimated as 2.4×10^{-9} Sv (2.4×10^{-7} rem) per year. Estimated annual dose to the maximally exposed adult individual due to liquid releases is estimated as 6.8×10^{-7} Sv (6.8×10^{-5} rem). Population doses through the liquid pathway are estimated as 4.9×10^{-2} person-Sv (4.9 person-rem) per year. An infant located at Bluegill Pond would be the critical receptor for the liquid pathway and receive an estimated annual dose of 6.0×10^{-6} Sv (6.0×10^{-4} rem). The maximum annual dose due to skyshine is estimated to be 2.6×10^{-5} Sv (2.6 mrem) to the resident located 1,235 meters south-southeast of the CEC. Doses estimated for normal operations are small fractions of the 1 mSv (100 mrem) dose (excluding potential exposure to indoor radon of 2 mSv) that an average individual receives in the U.S. from natural background radiation, and within regulatory limits.

It is estimated that maximum potential uranium deposition from airborne releases for a 30-year period would be about 7.4×10^{-6} Bq/cm² (2.0×10^{-4} pCi/m²) which if dispersed through the upper centimeter (0.4 in) of the soil, the average uranium concentration would not exceed 3.7×10^{-6} Bq/g (1.0×10^{-4} pCi/g). Similarly, if all the uranium contained in the entire 30-year volume of CEC liquid effluent were to accumulate in a one-centimeter layer of Bluegill Pond sediment, the uranium concentration would be 1.5×10^{-2} Bq/g (0.4 pCi/g). Given the conservative assumptions used in estimating these values, these concentrations are insignificant and their potential impacts on the environment and health are inconsequential. All discharges through Outfalls 001 and 002 will be regulated, and discharges from the sewage treatment system and yard drains will be monitored to minimize potential releases of contaminants. The potential impacts of liquid discharges to the environment are very small.

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Nonradiological Impacts:

Several design features and administrative procedures are employed to minimize gaseous and liquid effluent releases and keep them within regulatory limits.

Potential nonradiological impacts of operation of the CEC include releases of inorganic and organic chemicals to the atmosphere and surface waters during normal operations. As a consequence of purging of connector lines containing trace quantities of UF_6, atmospheric releases of hydrogen fluoride (HF) would occur during normal separation operations. The annual release rate is estimated as 6.5 kg with an associated maximum ground level concentration of 1.1×10^{-7} mg/m^3. As a consequence of equipment degreasing and laboratory operations, it is conservatively estimated that approximately 8,640 kg of the chlorofluorocarbon (CFC) solvent Freon R-113 would be released from the Separations Building stack each year. This amount represents the total inventory of this chemical; actual releases, however, would be significantly lower. Associated maximum ground level concentration is estimated to be 1.5×10^{-4} mg/m^3. As a consequence of centrifuge assembly operation, approximately 100 kg of acetone solvent and 400 kg of Freon R-113 would be released to the atmosphere each year. Associated maximum ground level concentrations of acetone and Freon R-113 are 1.0×10^{-3} and 4.0×10^{-3} mg/m^3, respectively. In all cases, estimated atmospheric concentrations are small fractions of the American Conference of Government Industrial Hygienists (ACGIH) time weighted average (TWA) guidelines for the chemical. Due to the EPA ban on CFC production in the U.S., LES has identified Axarel® 6000 and 9000 series as potential substitutes for Freon R-113. Axarel® is made up of aliphatic hydrocarbon and has very low toxic effects on the aquatic environment. Axarel® components have low vapor pressure that would limit the release of volatile organic compounds. Therefore, the expected impacts of use of this substitute are relatively less in magnitude than CFCs.

Nonradiological impacts include the increase of surface water discharge to Bluegill Pond. This additional discharge previously drained to Lake Avalyn. The total annual discharge to Bluegill Pond would be increased to approximately 389,500 m^3 compared to the current average flow of 286,000 m^3/yr of the stream that flows from Bluegill Pond. The flow in this stream is currently intermittent. The expected increase in average flow resulting from CEC

operation is likely to decrease the intermittent nature of the stream. A reduction in the elevation of the shallow and deep aquifers beneath the site is expected as a result of facility groundwater use and alteration of recharge patterns. The water supply for the facility will be pumped from the Sparta Sand Aquifer via two onsite wells. Although pumping may not be continuous, there would be a potential for cone depression in the Sparta Sand Aquifer water table in the vicinity of the wells. The net decrease of the water table at the site boundary may range from 0.03 to 1.2 meters for the 30-year pumping period. This change is localized in nature and is not expected to have any significant effect on the regional water supply. The alteration of the onsite recharge patterns may result in a reduction in the shallow groundwater depth directly beneath the site. This effect is not expected to be observed at offsite well locations. Potential releases of chemicals to surface water and groundwater resources during the CEC operation are very small with no significant impact.

The vegetation in the undeveloped wooded area of the site will continue to grow during the operational phase, forming a complete forest system. Impacts on land use and the botanical community will not exceed those which occurred during construction. Generally, the regrowth of the forest system will be associated with an improvement in the bio-diversity of the terrestrial ecosystem of the site.

Noise generated by the operation of CEC will be primarily limited to truck movements on the road. The noise at the nearest residence will probably increase; however, it may not be noticeable. While the incremental increases in noise level are small, some residents may experience some disturbance for a short period of time as they adjust to these increases. Noise related to the centrifuge systems is negligible and will not result in any disturbing noise beyond their buildings. Transportation will increase during worker shift changes, primarily on the roads leading to the plant site. It is expected that the maintenance of these roads would also increase.

The rerouting of Parish Road 39 will add approximately 120 meters (0.075 mile) to the road. The relocation will add approximately 600 meters (0.38 mile) to the traveling distance between Center Springs Church and Forest Grove Church. To prevent interruption in service, the existing road will be maintained in service until the new road is completed and available for use.

CEC would have minor impacts on local public services including education, health services, housing, and recreational facilities. The school system at Claiborne Parish has twice the physical capacity necessary to provide for the current student population. The increased economic activity and demand for night services and the potential crime increase may require additional public safety services. Although small, the potential public safety impact may be the most notable negative social impact of CEC operation. Health services, represented by Homer Memorial Hospital, have the ability to handle an approximate 30 to 35 percent increase in patient load without any problems. CEC operation would increase the demand for housing, thus stimulating new home construction, even though there is an oversupply of lower quality and older homes.

The benefits of CEC will mainly be in construction employment, operational employment, and indirect employment related to both. The plant will employ an average construction work force of about 200 per year for 6 years (275 per year over the peak 4 years of construction) and an average operations work force of about 180. Average annual earnings (including benefits) are estimated at about $37,000 for construction workers and $44,400 for operations workers (1990 dollars).

Within the labor pool, there are numerous individuals with the basic skills and experience for the lower and middle range jobs at CEC. LES plans to employ people in accordance with the Louisiana Enterprise Zone Act. This requires that LES certify that at least 35 percent of its employees: (a) are residents of the same parish as the location of the business; or (b) were receiving some form of public assistance prior to employment; or (c) were considered unemployable by traditional standards, or lacking in basic skills; or (d) any combination of the above. Adherence to the provisions of this Act should significantly improve the employment and income prospects of existing area residents. Lesser qualified individuals in the area may obtain jobs in the cafeteria, administration, and support services. Other benefits to the area will stem from the normal economic growth associated with large industrial projects in rural areas. This growth includes the secondary economic activity required to service and support the facility, the workers, and their dependents. No additional manufacturing facilities are expected to move to Claiborne Parish as a result of CEC.

At the higher-end, it is less likely that technically qualified applicants can be found locally. Economic migrants are increasingly likely to fill the available jobs. Residents are more likely to fill the lower skill jobs. At the very upper-end (e.g., health physicists, chemical engineers, etc.), individuals will mostly be brought in from existing high-technology chemical and nuclear facilities in other parts of the U.S. A significant amount of migration for the high-technology jobs can be expected.

Table S-1 shows the minimum estimated direct and indirect employment- and earnings-related benefits of CEC on the State of Louisiana. These estimates are based on the direct effects of CEC employment and payroll expenditures. The actual benefits could be substantially higher because of the very high absolute and per-worker construction expenditures and plant revenues. The employment values are annual averages over the 6-year and 30-year construction and operations periods, respectively. CEC will also have benefits in the areas of property values, tax revenues, and other areas.

Costs to Claiborne Parish and the region hosting the facility are expected to be minimal. In general, no significant impacts are expected in any local infrastructure areas (e.g., schools, housing, water, sewer). Costs will be diffused sufficiently to be indistinguishable from normal economic growth.

Any adverse effects are most likely to fall into three areas. First, the influx of direct and indirect workers and dependents during construction and operations may temporarily strain established social and community bonds and potentially increase crime. Such strains are not

Table S-1 Minimum Estimated Annual Employment and Earnings Benefits from CEC

	Construction	Operations
Direct Earnings	$8.5 Million	$8.0 Million
Employment	200	180
Multiplied Earnings	$17.7 Million	$17.0 Million
Multiplied Employment	450	600

unusual and are part of the normal process of adjustment when industrial development brings an influx of people to a rural area with a modest population and employment base. These effects are unlikely to be severe. Second, there may be some potential for displacement of existing residents as property values rise; again, these effects are likely to be small. Third, at the conclusion of the operations phase and the decontamination and decommissioning phase, the reduction in direct and indirect employment at CEC may result in socioeconomic dislocations in the area. Although this effect is not unique to CEC, it could be pronounced because of the nature of the CEC jobs compared to the existing employment base.

Because the CEC facility is capital-intensive and has low projected operating costs, once it is built, it will likely be operated for its lifetime. Operations would probably continue even if the plant cannot cover its fixed costs since operations would cover variable costs. Thus, property tax revenues (possibly at a reduced level) and employment for operations personnel should still be realized.

Decontamination and Decommissioning:

Decontamination and decommissioning of the facility at the termination of operations is projected to take approximately 7 years. Potential adverse environmental impacts would primarily be the release of small quantities of uranium to surface water as a consequence of decontamination operations. Releases and associated impacts are expected to be of the same order of magnitude or less than normal operational impacts. Decommissioning would also result in release of the facilities and land for unrestricted use, discontinuation of water and electrical power usage, and reduction in vehicular traffic.

Depleted Uranium Tails Disposal:

Enrichment operations at the CEC will generate about 3,800 metric tons of depleted uranium tails per year. LES proposes to store the tails onsite for up to 15 years, then ship the tails offsite in preparation for appropriate conversion to a more stable form and disposal. Currently, there are no conversion or disposal facilities in the U.S. for large quantities of depleted uranium. Therefore, the NRC staff evaluated expected environmental impacts based on plausible strategies for offsite conversion and disposal. The staff projects

that the tails will be converted from fluoride to the more stable oxide form, and disposed of in a deep geological facility or placed in long-term storage. The staff estimates that the environmental impacts associated with such a strategy will be small.

Environmental Justice:

The proposed site for the CEC is between two communities, Center Springs and Forest Grove, which consist almost entirely of African-American residents. The NRC staff carefully considered the issue of environmental justice; that is, whether the site selection process was based on racial considerations, and whether the impacts of the CEC would have a disproportionate adverse impact on minority and economically disadvantaged populations. The staff found no evidence that the site selection was based on racial considerations. Furthermore, although the persons living nearest the site are predominantly African-American, the staff concluded that the proposed CEC will not cause any significant adverse impacts on nearby residents or anybody else; and therefore, there will be no significant disproportionate adverse impact.

Conclusion:

In conclusion, analysis of the potential environmental impacts associated with construction and operation of CEC indicates that adverse impacts are small and are outweighed by the substantial socioeconomic benefits associated with plant construction and operation. Concurrently, NRC has completed a safety evaluation of the proposed facility (NUREG-1491), in which the NRC staff concluded that CEC operation will be conducted in a safe and acceptable manner. The FEIS supports licensing for LES.

FOREWORD

The information in this report will be considered by the U.S. Nuclear Regulatory Commission staff in the review of the license application by Louisiana Energy Services, L.P., to construct and operate a uranium enrichment facility to be located in Claiborne Parish, Louisiana. This report documents the potential environmental consequences of the proposed action.

ACRONYMS AND ABBREVIATIONS

AA	Atomic Absorption Spectrophotometry
ACGIH	American Conference of Government Industrial Hygienists
AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit for Intake
ANPR	Advance Notice of Proposed Rulemaking
ANSI	American National Standard Institute
AP	Air Particulate
AQCR	Air Quality Control Region
ASLP	Atomic Safety and Licensing Board
BA	Bachelor of Arts
bgs	Below Ground Surface
BNFL	British Nuclear Fuels
BOD	Biochemical Oxygen Demand
Bq	Becquerel
Bq/ml	Becquerel per Milliliter
BS	Bachelor of Science
BTEX	Benzene, Toluene, Ethyl Benzene, Xylene
BTU/hr	British Thermal Units per Hour
^{137}Cs	Cesium 137
CaF_2	Calcium Fluoride
$Ca(OH)_2$	Slaked Lime (Calcium Hydroxide)
$CaCo_3$	Calcium Carbonate
$C_6H_8O_7$	Citric Acid
C/kg	Coulomb per Kilogram
CAA	Clean Air Act
CAB	Centrifuge Assembly Building
CAM	Continuous Air Monitor
CANT	Citizens Against Nuclear Trash
CEC	Claiborne Enrichment Center
CEDE	Committed Effective Dose Equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CHP	Certified Health Physist
Ci	Curie

cm	Centimeter
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CWA	Clean Water Act
D&D	Decontamination and Decommissioning
dB	Decibel
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DCF	Dose Conversion Factors
DED	Louisiana Department of Economic Development
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DUF_6	Depleted Uranium Hexafluoride
DU_3O_8	Depleted Triuranium Octoxide
eH	Redox Potential
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Report
ESE	East-Southeast
FDI	Fluor Daniel, Inc.
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FNMC	Fundamental Nuclear Material Control
FR	Federal Register
ft	Feet
ft^3/sec	Cubic Feet per Second
g	Gram
g_a	Gravitational Acceleration
gal/yr	Gallon per Year
GAO	U.S. General Accounting Office
GDP	Gaseous Diffusion Plant
GEVS	Gaseous Effluent Ventilation System
gpd	Gallons per Day
gpm	Gallons per Minute
GW	Groundwater
H_2	Hydrogen
HC	HydroCarbon
HCFC	HydroChlorofluorocarbon

HEPA	High Efficiency Particulate Air Filter
HEU	Highly-Enriched Uranium
HF	Hydrogen Fluoride
HMTA	Hazardous Materials Transportation Act
HP&S	Health, Physics, and Safety
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz
ICP	Inductively Coupled Plasma
ICRP	International Commission on Radiological Protection
INFL	International Nuclear Fuels Plc
J/hr	Joules per Hour
JTU	Jackson Turbidity Unit
^{40}K	Potassium 40
kg	Kilogram
kg/yr	Kilograms per Year
km	Kilometer
kV	KiloVolt
l/sec	Liters per Second
l/yr	Liters per Year
L&NW	Louisiana and Northwest
LA	Louisiana
lbs	Pounds
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LES	Louisiana Energy Services
LEU	Low-Enriched Uranium
LLD	Lower Limits of Detection
LLW	Low-Level Waste
LNHP	Louisiana National Heritage Program
LP&L	Louisiana Power & Light Company
lpm	Liters per Minute
LWD	Liquid Waste Disposal
LWDPS	Louisiana Water Discharge Permit System
m	Meter
m_b	Magnitude
MBA	Master of Business Administration
MBq	Mega Becquerel
m/d	Meters per Day
m^3/yr	Cubic Meters per Year
MCE	Maximum Credible Earthquake

MEA	Master of Engineering Administration
mg	Milligram
mg/l	Milligrams per Liter
mg/yr	Milligrams per Year
mgpd	Million Gallons per Day
MM	Modified Mercalli
MOU	Memorandum of Understanding
mph	Miles per Hour
mR/hr	MilliRoentgen per Hour
mrem	Millirem
m/s	Meters per Second
MS	Master of Science
MSL	Mean Sea Level
mSv	MilliSievert
MVA	Mega Volt Ampere
MW	MegaWatt
NAAQS	National Ambient Air Quality Standards
NaF	Sodium Fluoride
NaOH	Sodium Hydroxide
NE	Northeast
NEHRP	National Earthquake Hazards Reduction Program
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NH_3	Ammonia
$(NH_4)_2U_2O_7$	Ammonium Diuranate
NHC	National Hurricane Center
NHPA	National Historic Preservation Act
NMSS	Nuclear Material Safety and Safeguards
NNW	North-Northwest
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NWS	National Weather Service
O_2	Oxygen
O_3	Ozone
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Act
Pa	Pascal

pCi	PicoCurie
pH	Measure of the Acidity or Alkalinity
Ph.D.	Doctor of Philosophy
PMF	Probable Maximum Flood
ppm	Parts per Million
PSD	Prevention of Significant Deterioration
psia	Pounds Force per Square Inch Absolute
R	Roentgen
RCA	Radiation Control Areas
RCRA	Resource Conservation and Recovery Act
RCZ	Radiation Control Zones
REM	Roentgen Equivalent Man
RIMS	Regional Input-Output Modeling System
SAIC	Science Applications International Corporation
SAR	Safety Analysis Report
SARA	Superfund Amendment and Reauthorization Act
scf	Standard Cubic Feet
SDWA	Safe Drinking Water Act
SER	Safety Evaluation Report
SNM	Special Nuclear Material
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
SPCC	Spill Prevention, Control, and Countermeasure
SPF	Standard Project Flood
STAR	Stability Array
STEL	Short Term Exposure Limits
Sv	Sievert
SW	Surface Water
SWD	Solid Waste Disposal
SWU	Separative Work Unit
TEDE	Total Effective Dose Equivalent
^{232}Th	Thorium 232
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSA	Technical Services Area
TSD	Treatment, Storage, and Disposal
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TWA	Time Weighted Average

U_3O_8	Triuranium Octoxide
^{235}U	Uranium 235
^{233}U	Uranium 238
UBC	Uniform Building Code
UCN	Ultra-Centrifuge Netherlands NV
UF_4	Uranium Tetrafluoride
UF_6	Uranium Hexafluoride
UO_2	Uranium Dioxide
UO_3	Uranium Trioxide
UO_2F_2	Uranyl Fluoride (Uranium Oxyfluoride)
UPS	Uninterruptable Power System
USEC	United States Enrichment Corporation
USGS	United States Geological Survey
VOC	Volatile Organic Compound
yd^3	Cubic Yard
yr	Year
μCi	MicroCurie
μCi/ml	MicroCuries per Milliliter
μg/l	Micrograms per Litre
$\mu g/m^3$	Micrograms per Cubic Meter
μm	Micrometer
μR/hr	MicroRoentgen per Hour
^{99}Tc	Technetium-99
χ/Q	Atmospheric Concentration per Unit Source

In accordance with 10 CFR Part 51, the applicant submitted, along with its license application (LES, 1991), an Environmental Report (ER) on January 31, 1991. This ER and subsequent revisions (LES, 1994a), provides background material for this EIS. In conducting the required NEPA review, NRC representatives (the staff) met with LES to discuss items of information in the ER, to seek additional information that was needed for an adequate assessment, and to generally ensure that the NRC thoroughly understood the proposed project. In addition, the staff sought information from other sources to assist in the evaluation, met with State of Louisiana and U.S. Environmental Protection Agency (EPA) officials, and conducted a public scoping meeting to help identify the significant issues to be analyzed in depth. On the basis of these and other such activities or inquiries, the staff has made an independent assessment of the considerations specified in 10 CFR Part 51.

That evaluation led to the issuance of a Draft Environmental Impact Statement (DEIS) by the NMSS in November 1993. The DEIS was distributed to Federal, State, and local governmental agencies and other interested parties for comment. A notice was published in the Federal Register (58 FR 62148) regarding the availability of the DEIS and inviting public comment on the document. The public comment period scheduled to end on January 10, 1994, was extended to January 25, 1994, by a second notice in the Federal Register (58 FR 68969).

After comments on the DEIS were received and considered, this FEIS was prepared. This includes a discussion of the questions and comments received on the DEIS (Volume 2, Appendix B). Further environmental considerations were made on the basis of these comments in combination with the previous evaluation.

This FEIS was made available to the EPA, people and organizations commenting on the DEIS, and the public.

1.2 The Applicant's Proposal

LES has applied to the NRC for a license to construct and operate a facility to enrich natural uranium to a maximum of 5 weight percent uranium-235 (^{235}U) by the gas centrifuge process at a site located in Claiborne Parish, Louisiana (LES, 1991). The facility, to be known as Claiborne Enrichment Center (CEC), would be located approximately 8 kilometers (km) (5 miles) northeast of Homer (Figure 1.1), near small rural communities known as Forest Grove and Center Springs.

The plant is designed to separate a feed stream containing the naturally occurring proportions of uranium isotopes into a product stream enriched in the ^{235}U isotope and a tails stream depleted in the ^{235}U isotope. The plant design capacity is 1.5 million Separative Work Units (SWU) per year. At full production in a given year, the plant will receive approximately 4,700 metric tons (4.7 million kg or 10.3 million lbs) of feed uranium hexafluoride (UF_6), and produce 870 metric tons (870,000 kg or 1.914 million lbs) of low-enriched UF_6 and 3,800 metric tons (38 million kg or 83.6 million lbs) of depleted UF_6 tails.

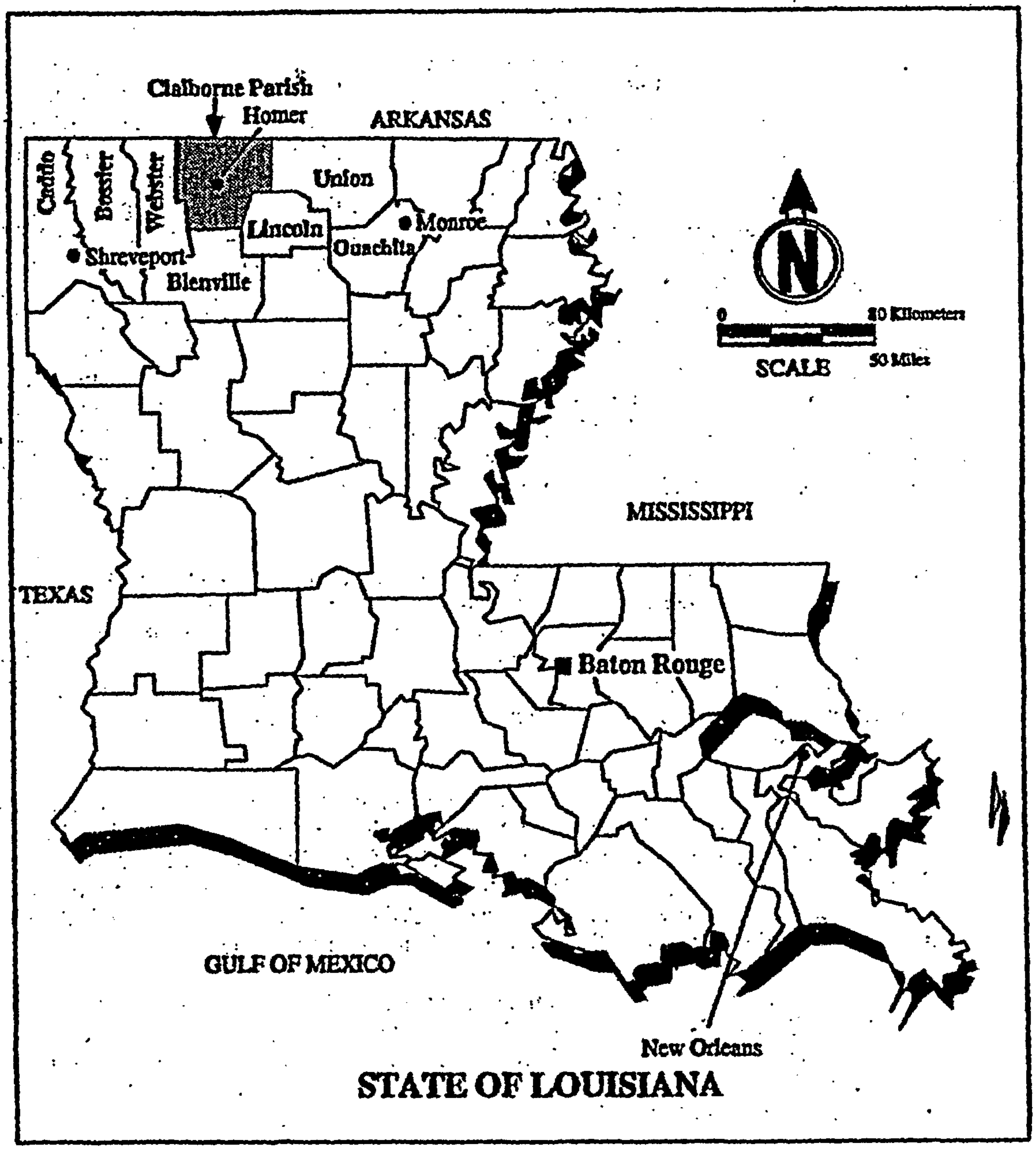


Figure 1.1 Proposed Location of the Claiborne Enrichment Center (CEC)

1.3 Background Information

In accordance with the Solar, Wind, and Geothermal Power Production Incentives Act of 1990 revision of the Atomic Energy Act of 1954 (P.L. 101-575), the type of uranium enrichment facility proposed by LES must be licensed in accordance with the provisions of the Atomic Energy Act pertaining to source material and special nuclear material. Therefore, the primary bases for review of the application are the regulations of 10 CFR Parts 40 and 70. In addition, by Commission Order, the draft "General Design Criteria" for uranium enrichment, published in the Advance Notice of Proposed Rulemaking (ANPR) for 10 CFR Part 76 (NRC, 1988a), and other special standards and instructions apply with the same force as final NRC regulations. The Commission Order specifies that for the purpose of siting and designing a facility against accidental atmospheric releases of UF_6, health and safety criteria contained in NUREG-1391, "Chemical Toxicity of Uranium Hexafluoride Compared to Acute Effects of Radiation," (NRC, 1991b) shall be applied. The criteria include a limiting intake of uranium in soluble form of 10 milligrams and a limiting exposure to hydrogen fluoride (HF) at a concentration of 25 milligrams per cubic meter for 30 minutes. Other NRC regulations which apply, according to their terms, include 10 CFR Parts 19, 20, 21, 30, and 140. Other Federal and State requirements are identified in Chapter 6.

LES, a Delaware limited partnership, consists of four general partners and seven limited partners. The four general partners are Urenco Investments, Inc.; Claiborne Fuels, L. P. (a subsidiary of Fluor Daniel, Inc.); Claiborne Energy Services, Inc. (a subsidiary of Duke Power Company); and Graystone Corporation (a subsidiary of Northern States Power Company). The limited partners are Louisiana Power & Light Company; BNFL Enrichment, Ltd.; GnV; UCN Deelnemingen V. B.; Claiborne Energy Services, Inc.; Le Paz Inc.; and Micogen Limited III, Inc.

There is opposition to the facility. The organization Citizens Against Nuclear Trash (CANT) opposes facility licensing. A formal adjudicatory hearing by the NRC Atomic Safety and Licensing Board (ASLB) will be held. The FEIS and the NRC staff's Safety Evaluation Report (SER) (NRC, 1994), will provide the foundation of the staff input for the ASLB proceeding. Parties in the proceeding are CANT, LES, and the NRC staff. After this hearing is completed, the ASLB will issue its decision on LES's license.

The staff has recently completed an SER for the CEC (NRC, 1994). This SER was published as NUREG-1491 in January 1994. As part of the safety review for the facility, the staff reviewed the Emergency Plan, the Fundamental Nuclear Material Control Plan, and the Physical Security Plan. The acceptability of these plans is documented in the SER and is not discussed in this EIS.

1.4 Need for the Proposed Action

Because existing world enrichment capacity is projected to be adequate to meet demand for the foreseeable future (General Accounting Office, 1991), the need for this facility lies primarily in the need for an additional market competitor in the U.S., rather than in a need to increase world or U.S. enrichment capacity. By the year 2000, the U.S. requirements for enriched uranium are expected to increase slowly to 8.91 million SWUs (Table 1.1) (Energy Resources International, 1991). Premature reactor shutdowns would affect the demand for enriched uranium, however, at this time it is not possible to quantify this effect. As of 1990, the U.S. Department of Energy (DOE) supplied approximately 89 percent of the national purchases of enriched uranium. Within the same year, Eurodif of France supplied approximately 4 percent of U.S. purchases, while independent brokers and traders provided the remainder. However, LES projects that by 1996, U.S. customers will have committed to purchase only about 40 percent of their enrichment requirements for the late 1990s through contracts with DOE (LES, 1992f). Thus, 60 percent of these requirements remains uncommitted. Approximately 70 percent of the requirements in 2000 are uncommitted. Within the U.S., LES believes that termination and expiration of long-term contractual commitments for enrichment services between DOE and commercial utilities provides an opportunity for a competing company to successfully enter the market. Figure 1.2 shows the projected U.S. requirements for enrichment services and the committed and uncommitted portions of these services. The production from this proposed facility would represent approximately 17 percent of the estimated U.S. requirements for enrichment services in the year 2000. LES, as a potential domestic supplier of enrichment services, would be directly competing with the United States Enrichment Corporation (USEC), which now operates the DOE enrichment facilities, and with foreign suppliers.

There are three important reasons why CEC could be an effective competitor to the U.S. Gaseous Diffusion Plants (GDPs) over the long-term. First, the GDPs are more than 40 years old and in need of extensive maintenance and upgrades. Second, the GDPs use about 50 times as much electrical energy per SWU as CEC will use. Also at high production rates, unit electric costs for the GDPs rise even further and electrical efficiency falls. Enrichment is the largest cost component in producing nuclear fuel and electricity (for the U.S. diffusion plants) is the largest cost component of the enrichment service. Third, the three coal-fired plants that supply the GDPs are in a category identified in the Clean Air Act (CAA) Amendments of 1990 for substantial reductions in air emissions. The investments necessary at these plants could result in increases in the cost of power to the GDPs. LES output could lessen U.S. reliance on these energy-intensive plants.

In 1993, the U.S. and Russia reached an agreement which provides for the U.S. to buy Russian low-enriched uranium (LEU) blended down from highly-enriched uranium (HEU). Under this May 1993 agreement, Russia will supply LEU with the equivalent of 92.1 million SWUs over the 1994-2013 period (15.2586 million kg LEU with 6.0386 SWUs per kg) (Nucleonics Week, 1993). Ten percent of the LEU, or approximately 1.8 million SWUs/year will be supplied in the 1994-1998 period. Ninety percent of the LEU, or

Table 1.1 World Enrichment Services Requirements, Mid-Range Projection[a] in Millions of SWU (Copyright © 1991 by Energy Resources International, Inc.)

Year	U.S.[b]	Western Europe[c]	Far East	Central Europe	Other	World Excluding Russia	Russia	World
1993	8.71	10.47	4.45	1.21	0.61	25.45	4.75	30.20
1994	8.76	10.13	4.45	1.31	0.80	24.45	5.29	30.74
1995	8.75	10.27	4.58	1.18	0.83	25.61	5.09	30.70
1996	8.59	10.20	4.58	1.09	0.67	25.13	5.08	30.21
1997	8.75	10.17	4.88	1.10	0.90	25.80	5.26	31.06
1998	8.75	10.31	5.07	1.25	0.90	26.27	5.29	31.56
1999	8.74	10.30	5.04	1.18	0.92	26.17	5.30	31.47
2000	8.91	10.69	5.21	1.14	0.93	26.87	5.50	32.37
2001	8.91	11.10	5.24	1.46	1.04	27.74	5.60	33.34
2002	8.91	11.12	5.48	1.46	1.20	28.16	5.69	33.85
2003	8.99	11.23	5.43	1.47	1.44	28.56	5.78	34.34
2004	8.92	11.54	5.61	1.47	1.36	28.90	5.87	34.77
2005	8.99	11.79	5.85	1.41	1.26	29.30	5.97	35.27
2006	9.10	12.01	5.83	1.41	1.26	29.61	6.06	35.67
2007	9.21	11.79	5.78	1.73	1.22	29.73	6.16	35.89
2008	9.33	12.49	6.12	2.04	1.38	31.36	6.25	37.61
2009	9.57	12.69	6.25	1.91	1.35	31.77	6.34	38.11
2010	9.81	12.66	6.23	1.76	1.26	31.72	6.43	38.15
2011	9.97	12.62	6.46	1.76	1.47	32.28	6.53	38.81
2012	10.13	12.56	6.71	1.92	1.47	32.79	6.62	39.41
2013	10.28	12.79	6.66	2.39	1.48	33.60	6.68	40.28
2014	10.44	13.06	6.78	2.31	1.64	34.23	6.77	41.00
2015	10.56	12.95	6.81	2.11	1.60	34.03	6.83	40.86
2016	10.68	12.80	6.98	2.27	1.52	34.25	6.90	41.15
2017	10.82	12.83	7.10	2.27	1.65	34.67	6.96	41.63
2018	10.96	13.12	6.99	2.34	1.65	35.06	6.98	42.04
2019	11.01	12.80	7.01	2.66	1.71	35.19	7.04	42.23
2020	11.08	12.68	7.37	2.75	1.87	35.75	7.06	42.81
2021	11.19	12.95	7.42	2.60	1.79	35.95	7.10	43.05
2022	11.30	12.93	7.31	2.51	1.70	35.75	7.13	42.88
2023	11.41	12.57	7.46	2.64	2.13	36.21	7.18	43.39

Table 1.1 World Enrichment Services Requirements, Mid-Range Projection[a] in Millions of SWU (Copyright © 1991 by Energy Resources International, Inc.) (Continued)

Year	U.S.[b]	Western Europe[c]	Far East	Central Europe	Other	World Excluding Russia	Russia	World
2024	11.74	12.43	7.54	2.78	2.27	36.76	7.08	43.84
2025	12.07	12.52	7.51	3.00	2.02	37.12	7.11	44.23
2026	12.24	12.41	7.56	2.88	2.09	37.18	7.07	44.25
2027	12.33	11.86	7.62	2.72	2.36	36.89	7.08	43.97
2028	12.33	12.18	7.69	3.04	2.28	37.52	7.09	44.61
2029	12.39	12.22	7.88	3.01	2.25	37.75	7.15	44.90
2030	12.13	12.47	7.81	2.86	2.41	37.68	7.21	44.89

[a] Includes the effects of projected tails assays, nuclear plant capacity factors, and recycle savings.
[b] Does not include U.S. Government requirements of approximately 1 million SWUs per year.
[c] Includes U.K. requirements for the recycling of depleted uranium arising from reprocessed Magnox fuel.

approximately 5.53 million SWUs per year, will be supplied in the 1999-2013 period. This latter period coincides with the first 15 years of production from CEC. It also coincides with the large uncommitted market for SWUs around the turn of the century.

In quantitative terms, the Russian LEU to be supplied during the 1999-2013 period represents about 15 percent of projected world demand and more than 50 percent of projected U.S. demand. The Russian LEU also represents almost half of all uncommitted world demand during the period. The Russian supplies are about 3.7 times larger than the CEC output during the coincident 15-year period. USEC will acquire the Russian LEU at a 1994 base price of $82.10 per SWU (Nucleonics Week, 1993).

In 1992, LES acknowledged the possibility of foreign HEU-to-LEU conversions depressing the market, but believed that its view of the need for SWUs would not be affected. In a letter to the NRC dated April 30, 1992, LES stated that it believed that "the most likely possibility would be that the nations involved would reserve some of this material for naval propulsion reactors and release the rest, if at all, over a period of years in a manner so as not to disrupt commercial production. It has also been mentioned that such material might be used to replace more expensive DOE GDP capacity, resulting in no net gain of marketed production" (LES, 1992f).

The Energy Policy Act of 1992 (P.L. 102-486) stipulates that USEC should seek to minimize the impact on domestic industries in selling the LEU. The Energy Policy Act of 1992 and the U.S.-Russia agreement anticipate that domestic competition will exist and should not be adversely affected by the HEU agreement.

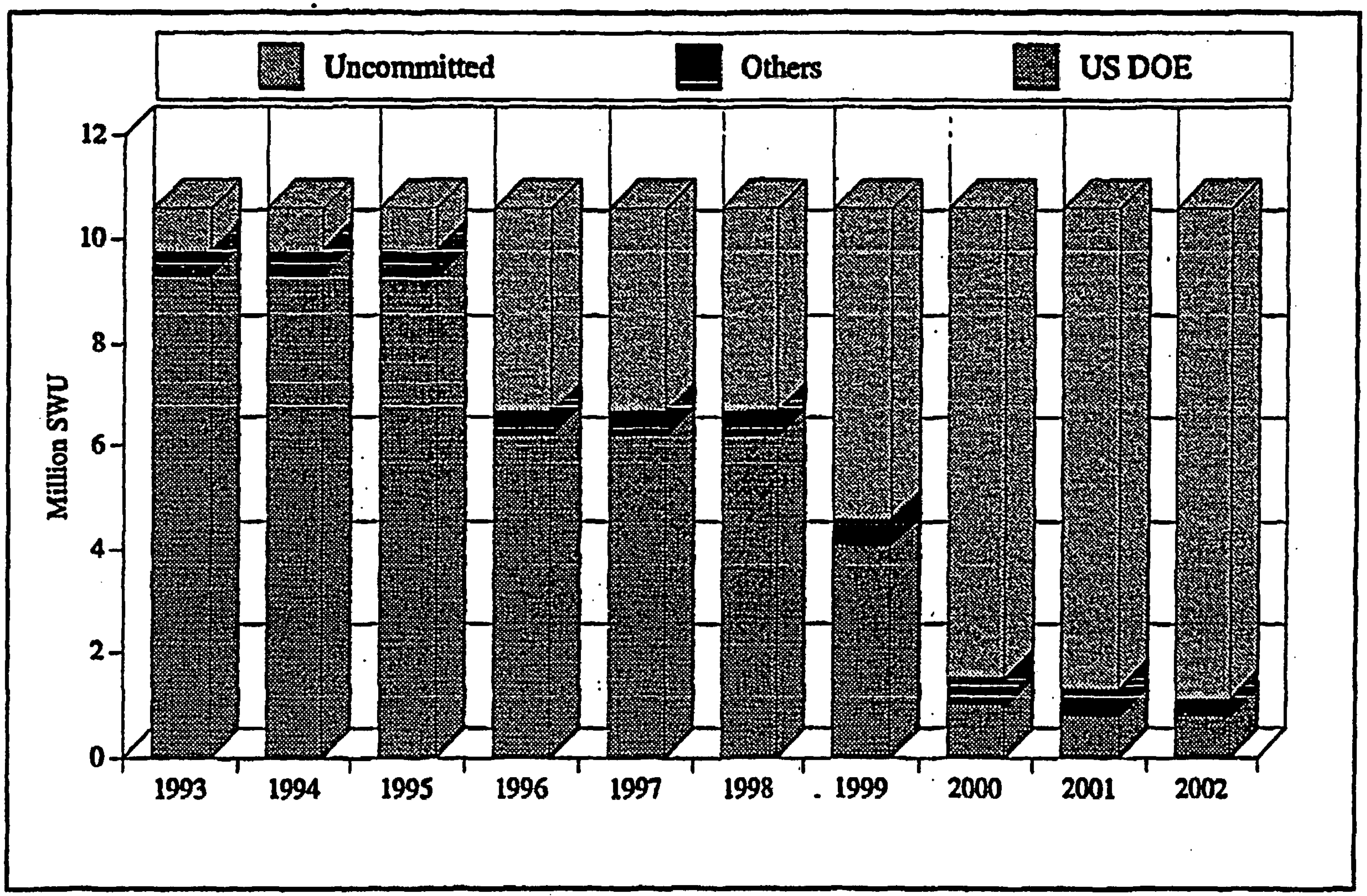


Figure 1.2 Projected U.S. Requirements for Enrichment Services
(Copyright © 1991 by Energy Resources International, Inc.)

USEC has not explained how it will market its combined Russian and American LEU production. Russian LEU combined with scheduled SWU output at existing U.S. enrichment plants would oversupply the U.S. market. Implementation of the U.S.-Russia agreement might, as LES notes, allow the U.S. to consider shutting down one of the two currently operating GDPs.

If licensed, LES would become the only private producer of enriched uranium in the U.S. Several utilities and others, in commenting on the DEIS, supported the addition of a domestic source of enriched uranium to compete with USEC.

1.5 Scoping Process

In accordance with 10 CFR Part 51, NRC utilized a scoping process to identify significant issues concerning this proposed project. On June 28, 1991, the NRC published in the Federal Register (56 FR 29727) a Notice of Intent to prepare an Environmental Impact Statement for the construction and operation of the proposed CEC and to conduct a scoping process. The scoping process also included a public scoping meeting which was held in the Homer High School cafeteria on July 30, 1991. The scoping process is summarized in a separate report (NRC, 1991a), available in the Public Document Room in Washington, DC, and in the Local Public Document Room in the Claiborne Parish Library in Homer, Louisiana. The major issues raised by the commentors at the scoping meeting included environmental consequences, socioeconomic impacts, local emergency response capabilities, waste disposal, safety, and the roles of the NRC and State of Louisiana. Meetings have also been held with State of Louisiana officials and EPA Region 6 officials.

1.6 Status of Actions by Federal and State Agencies

The only regulatory action required from the NRC is the licensing decision on the LES application to construct and operate a uranium enrichment facility near Homer, Louisiana. In addition, LES must obtain all necessary local, State, and Federal permits and licenses prior to the initiation of various stages of construction and operation of the facility. This includes certification under Section 401 (a)(1) of the Clean Water Act (CWA) and approval to construct CEC in accordance with requirements of National Emissions Standards for Hazardous Air Pollutants (NESHAPS) in 40 CFR Part 61.07. The National Pollutant Discharge Elimination System (NPDES) application to the EPA and the waste water discharge permit with the Louisiana Department of Environmental Quality (LDEQ) approvals are still pending. LDEQ has recommended rerouting of Outfall 001 around Bluegill Pond. The air emissions discharge permit application was filed on June 30, 1992, with LDEQ and is still pending. EPA NESHAPS approval is also still pending.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes the alternatives considered in this FEIS, including the no-action alternative (license denial) and the proposed action to issue a license to LES for the construction and operation of the Claiborne Enrichment Center (CEC). Alternative uranium enrichment technologies are discussed briefly but eliminated from further consideration. The siting approach and activities pursued by LES are presented in order to evaluate the reasonableness of the applicant's approach.

2.1 No-Action

The no-action alternative is the denial of LES's application. Under this scenario, LES would not receive a U.S. Nuclear Regulatory Commission (NRC) license to construct and operate the CEC, therefore the facility could not be built. As owner of the land, LES could sell or perhaps lease the property for possible agricultural, timbering, or other industrial uses. Under this alternative, Parish Road 39 would probably not need to be relocated.

2.2 Alternative Enrichment Technologies

LES proposes to use the gas centrifuge enrichment process for the CEC. However, alternative enrichment technologies could be considered for this facility, such as gaseous diffusion technology, which involves the pumping of gaseous uranium hexafluoride (UF_6) through diffusion barriers resulting in the gas exiting the barrier slightly enriched in the isotope ^{235}U. The gas that does not pass through the barrier is depleted in ^{235}U. The diffusion barriers and their associated compressed gases are staged (similar to the staging of centrifuges) to produce higher enrichments of practical value. This technology, developed in the 1940s and 1950s in the U.S., was used for the enrichment plants built in the U.S.. Higher energy consumption, increased capital cost requirements, and no environmental advantages characterize this technology. The amount of electrical energy required to produce one separative work unit (SWU) is approximately 50 times higher than the energy required for centrifuge technology.

Another alternative technology is laser enrichment. This advanced version of the enrichment technology involves the generation of uranium metal vapor, which is then exposed to light of a specific wavelength from a laser. This light selectively excites specific uranium isotopes, allowing electrons to be stripped from the excited isotopes. As a result, vapor-phase ions are created, which can be separated from the rest of the uranium vapor in a magnetic field. This technology, when developed, could have both environmental and economic advantages, although these advantages have not yet been proven on a commercial basis. Also, since this technology utilizes uranium metal, one or more production facilities would be needed to support the process. One facility would be needed to convert uranium in yellowcake form to uranium metal which would be used as feed material, and the other

facility would convert the enriched uranium metal into a form that could be utilized by the fuel fabricator.

Because of the high amount of electrical energy required for gaseous diffusion and because laser enrichment is not commercially available and would require construction of support facilities, neither of these technologies were considered acceptable alternatives and were thus eliminated from further consideration.

2.3 Proposed Action

The proposed action is the issuance of an NRC license to construct and operate a 1.5 million SWU/year uranium enrichment facility at the CEC near Homer, Louisiana. The facility will be used for enriching natural UF_6, containing 0.71 weight percent of ^{235}U, into a product stream containing up to 5 weight percent ^{235}U and a tails stream containing 0.2 to 0.34 weight percent ^{235}U. LES is planning a phased construction of three identical units, each with a capacity of approximately 0.5 million SWUs per year. This capacity is based on operations at an availability of 100 percent or 8,760 hours per year. Approximately 4,700 metric tons of UF_6 will be processed annually when CEC is in full production, generating approximately 866 metric tons of low-enriched uranium and approximately 3,830 metric tons of depleted uranium tails (DUF_6).

The total estimated time required to construct the CEC is 6 years. The CEC would be constructed in three phases. Each phase would result in a 0.5 million SWU unit, with the first unit beginning operation prior to the completion of phases 2 and 3. If licensed, LES would receive a 30-year construction/operation license. Decontamination and decommissioning (D&D) of the CEC is expected to take 7 years. Direct capital cost of the CEC is estimated to be $855 million (in 1990 dollars), exclusive of escalation, capitalized interest, contingency, or replacement centrifuges (LES, 1992h). Decommissioning is estimated to cost $518 million (in 1996 dollars), of which almost 94 percent is for disposition of tails. In 1990 dollars, decommissioning is estimated to cost $409 million. The total investment, including direct construction, interest, escalation, capitalized interest, contingency, replacement centrifuges, decontamination, and decommissioning is estimated at $1.6 billion (1990 dollars).

The following sections discuss LES's site selection process, construction and operation of the CEC, and D&D. Section 2.3.1 describes the LES site selection process; Section 2.3.2 addresses construction of the CEC; Section 2.3.3 addresses operation of the CEC; Section 2.3.4 addresses the waste management systems; and Section 2.3.5 addresses D&D of the CEC. These sections discuss the nature of the activities associated with each phase of facility life, the resources required for support, and the wastes that would be generated.

2.3.1 The LES Site Selection Process

This section describes the process that LES utilized to choose a site for the CEC. The NRC staff did not participate in the LES site selection process. However, the NRC staff believes that the approach used by LES was reasonable. The site that was ultimately selected by LES, and for which an NRC license is sought for the construction and operation of this proposed facility, was the LeSage site near Homer, Louisiana. Other alternative sites considered by LES are not alternatives available to the NRC, and are therefore not alternative actions for the purpose of this EIS.

LES followed a three-phased screening process to identify a suitable site for the CEC. The three phases were: (1) identification of candidate regions, (2) determination of potential areas, and (3) selection of alternative locations and sites. For each phase, LES used a set of economic, technical, social, and environmental criteria.

In the initial phase of the site selection process, LES identified key characteristics of the proposed facility and the site:

- The enrichment facility is best characterized as a specialty chemical plant; it takes in a particular chemical feed, processes it, and yields a product.
- The facility requires a medium-sized site (i.e., hundreds of acres), but not a large site (i.e., thousands of acres). Most of the land would be used as a buffer zone, not for buildings.
- The facility requires good road access for trucks bringing in feed material and shipping out product material. Feed and product are not expected to be moved by rail or air.
- The facility requires an adequate, reliable supply of electrical power.
- The facility requires a source of workers capable of operating the plant efficiently and safely.
- The durability and reliability of the process is dependent on being located in an area that exhibits minimal seismic activity.
- The facility should not be located in an area that experiences severe winds or tornados.
- In order to prevent damage to expensive equipment and to obviate the need for flood-proofing of the site, the site should not be flood-prone.

- The facility should be developed in a locale where it would be considered an asset to the community.

2.3.1.1 Candidate Regions Screening Level

For this level of evaluation, LES followed a broad approach to identify geographical regions within the U.S. suitable for the proposed site. LES defined this phase as the coarse screening process for regions. The siting criteria used for this coarse screening phase are outlined below:

- The location should be within the service district of one of the LES utility sponsors. Siting of the facility in or near the service area of these utilities would promote local community acceptance of the project and provide a pool of knowledge of local and regulatory issues. Figure 2.1 identifies the service areas of the electric utility sponsors of LES.

- The location should be near expected major feed suppliers and product receivers. Shorter transportation distance is an important business and environmental criterion because it contributes to cost containment, increases the margin of safety, and reduces potential environmental consequences. In other words, the shorter the distance for travel, the less likely an accident would occur, and the cheaper the shipment would be. Domestically, UF_6 feed is obtainable from plants in Oklahoma and Illinois. (The facility in Oklahoma was shut down after the LES site selection process was completed.) The enriched UF_6 may be shipped to Hanford, Washington; Columbia, South Carolina; Wilmington, North Carolina; Windsor, Connecticut; Lynchburg, Virginia; or Hematite, Missouri. (The facility in Connecticut has been shut down.) Two 966-km (600-mile) radii from both the centroid of the feed material sources and the centroid of the product destinations were considered and are presented in Figure 2.2. The intersection of the source boundary and the destination boundary was defined as the most favorable transportation region.

- The likelihood of natural forces (winds and earthquakes) should be minimal in order to reduce the cost of facility construction and operation. For reliable operation of the centrifuge technology, an effective peak acceleration of less than 0.49 m/s^2 or 0.05 gravitational acceleration (g_a) was chosen. This maximum permissible acceleration value was based on input from the centrifuge machine manufacturer. Thus, the facility should be located in an area having less than this g_a rating. The anticipated effective peak g_a throughout the U.S. is presented in Figure 2.3.

- The facility should not be located in an area with severe storms that could cause loss of power, flooding, and wind damage to buildings and centrifuge

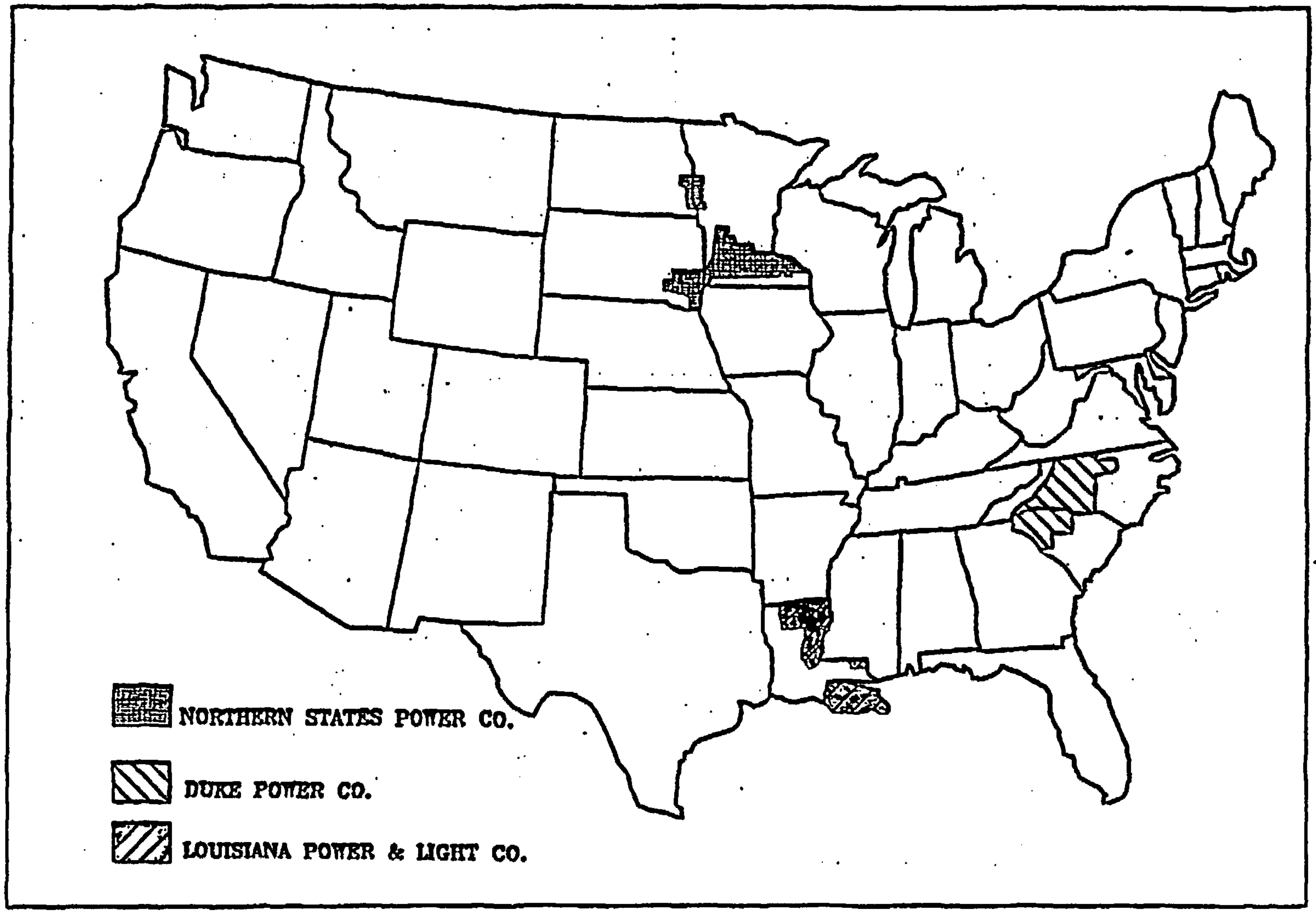


Figure 2.1 Investor-Owned Electric Utility Service Area (LES, 1994a)

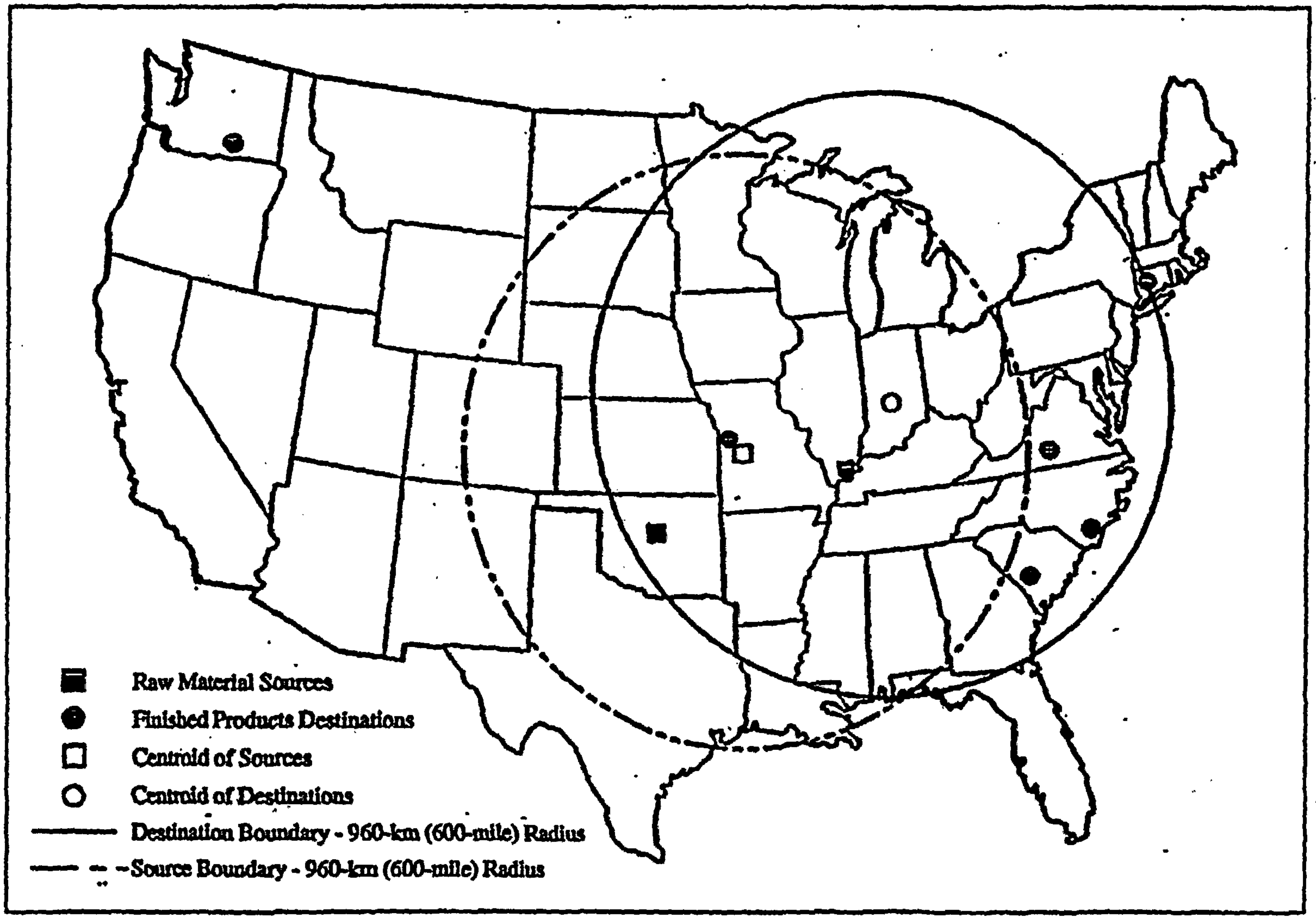


Figure 2.2 Locations of Feed Material Sources and Product Destinations (Adapted from LES, 1994a)

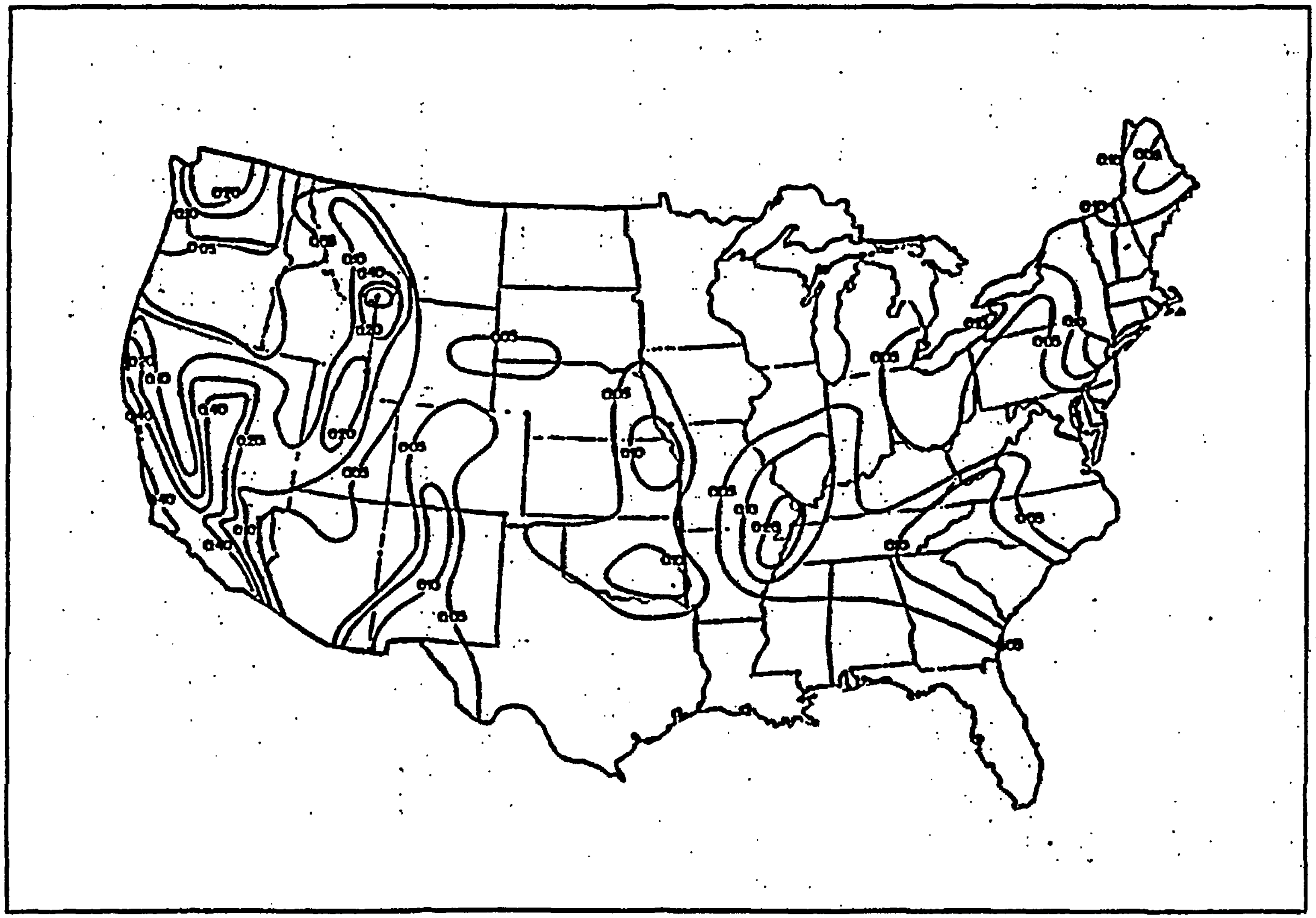


Figure 2.3 Contour Map for Effective Peak Acceleration through the U.S. (Department of Commerce, 1982)

machines. Those regions of the country with peak straight-line wind speeds less than or equal to 31 meters per second (m/s) [70 miles per hour (mph)] were identified as being favorable areas (Figure 2.4).

- The location should have a favorable business climate exemplified by communities with large labor pools available and States having right-to-work laws.

- The location should be in a region with moderate climate to ensure safety and reliability. The movement of feed material to and product from the enrichment facility will be via roadways. Areas with severe winter climates are less desirable because the presence of ice and snow could disrupt the movement of personnel and equipment and reduce the margin of transportation safety.

Three regions were identified based on investor utility service areas: southern Minnesota, western North Carolina and South Carolina, and northern and southern Louisiana (Figure 2.5).

Siting in southern Louisiana was less desirable because this service district is located in an area where there is a higher frequency of hurricanes and tornados and a greater potential for flooding. Southern Minnesota was eliminated from further consideration for business-related reasons and because of the severe winter weather and annual peak straight-line wind speeds in excess of 31 m/s (70 mph). The North Carolina and South Carolina utility service areas were removed from consideration because the effective peak acceleration of earthquakes exceeded 0.49 m/s^2 (0.05 g_a).

Northern Louisiana was selected as the candidate region because it possessed the most favorable combination of environmental and business characteristics:

- Louisiana Power and Light (LP&L), an LES partner, serves areas in northern Louisiana.

- Northern Louisiana is within the zone that is attractive for transportation of feed and product.

- Northern Louisiana is an area of low seismic activity (i.e., < 0.05 g_a). Seismicity studies that include northern Louisiana indicate that the area is one of the lowest seismic risk areas of the U.S. for near-field shocks (high frequency of vibration) and distant events (low frequency of vibration).

- Northern Louisiana is within the zone that experiences a peak straight-line wind speed less than or equal to 31 m/s (70 mph).

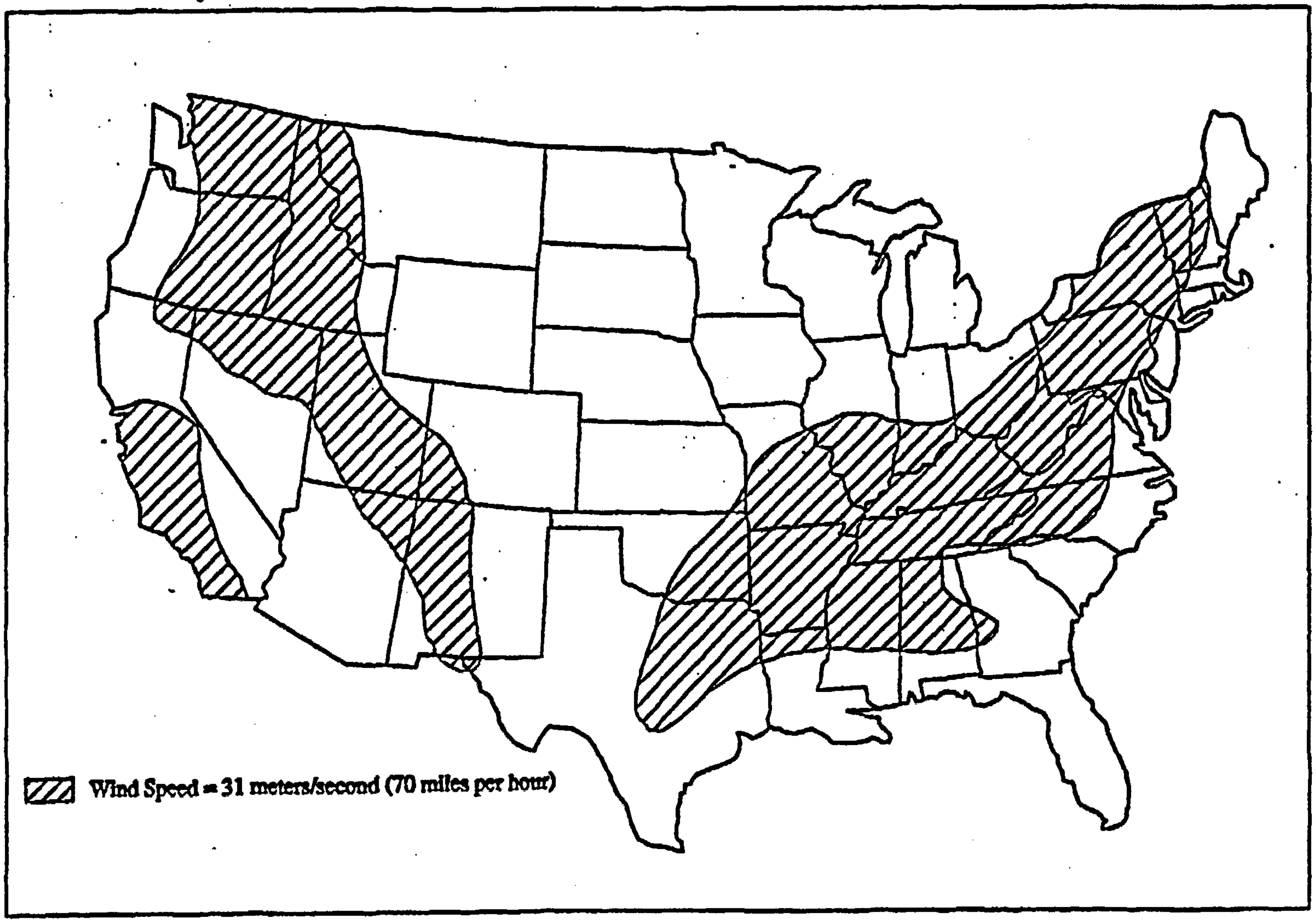


Figure 2.4 The 70 mph (31 m/sec) Wind Speed Zone in the U.S. (LES, 1994a)

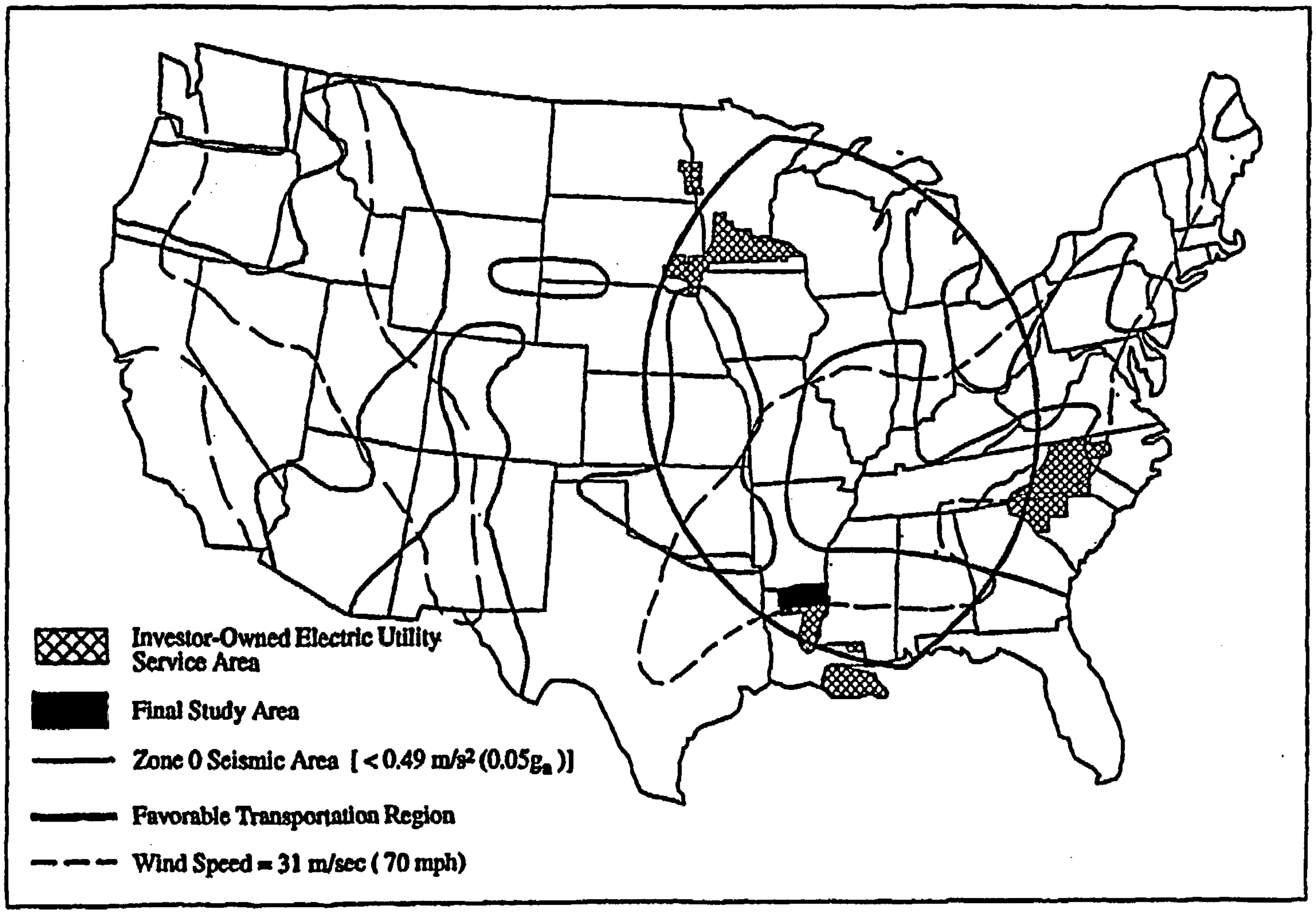


Figure 2.5 The Collective Siting Factors and Criteria Interactions for Selecting Northern Louisiana as the Preferred Region for CEC (LES, 1994a)

- The state of Louisiana actively pursues new industry, and this attitude is evidenced at all levels of government - Federal, State, and local. The government of the State of Louisiana has adopted a number of programs aimed at attracting new businesses into the State. Qualified new manufacturing businesses are exempt from *ad valorem* taxes for 10 years. This amounts to a savings to LES of approximately $64 million. Under the Enterprise Zone concept, qualifying businesses can be exempted from State and local sales taxes and may be eligible for certain tax credits. The Freeport Law is available to reduce certain taxes or delay their payments. Moreover, the Louisiana Department of Economic Development (DED) pays for certain pre-employment training of workers.

- Louisiana features a warm, humid, subtropical climate with only occasional snowfalls, thus minimizing the possibility of weather-related interruptions in operation.

- Louisiana has right-to-work laws in effect.

2.3.1.2 Candidate Communities Screening

The coarse screening process that led to choosing the northern Louisiana region was followed by a two-phased intermediate screening process. The first phase called for identifying communities in northern Louisiana that met the candidate region screening criteria. The second phase focused on the selection of the final community. In the first phase, communities in northern Louisiana that were located within 72 km (45 miles) of Interstate 20 were solicited by LES for their interest in being the host site for a new manufacturing facility. The Louisiana DED provided assistance in contacting appropriate community leaders. The communities were requested to nominate potential sites for a proposed chemical facility using the following criteria:

- The size of the site had to range from 121 to 404 hectares (300 to 1,000 acres), preferably shaped in a square configuration.

- The site had to be singularly owned and available for sale.

- Locations with no operating oil or gas wells were preferable.

- Good road access to the site was desirable.

Twenty-one communities responded with offers (Figure 2.6). Each of these candidate communities were visited for visual inspection by site selection personnel. Of these 21 communities, 12 communities were eliminated using the following screening criteria:

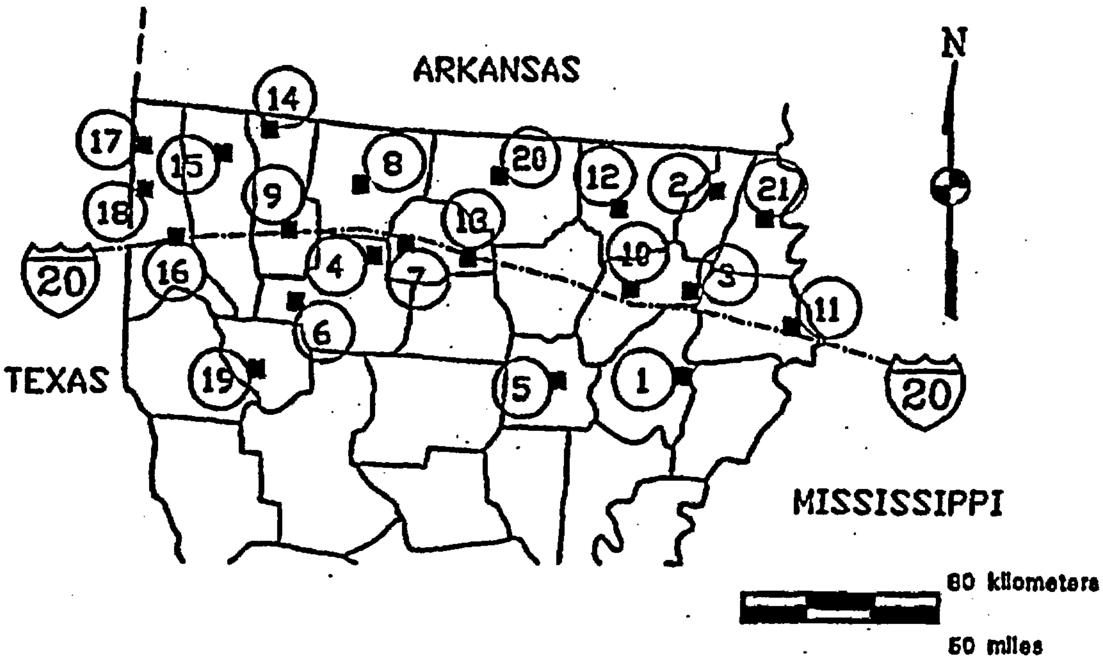
- The site had to be within the LP&L service area.
- Communities with existing major industrial facilities were avoided.
- The community needed to have a strong manufacturing mentality that was conducive to new industry.
- The site had to have stable soils not prone to subsidence.
- Properties having operating oil or gas wells were avoided.
- Flood-prone properties were avoided.
- Communities with active, cohesive leadership that would consider the plant an asset were desired.
- Construction of the site had to be compatible with existing land use.
- Large urban areas were avoided.

Table 2.1 illustrates the specific reasons for eliminating 12 communities. The nine remaining candidate communities in northern Louisiana were Winnsboro, Oak Grove, Delhi, Gibsland, Columbia, Ringgold, Arcadia, Homer, and Minden.

The second phase of the intermediate screening process involved a comparative evaluation of the nine remaining candidate communities using the weighted score method. This decision-making methodology defined criteria as either "musts" or "wants." If an alternative did not meet the "must" criteria, it was eliminated. The remaining alternatives were scored on how well they satisfy the "wants" criteria.

The "must" criteria were:

- LP&L had to be able to provide at least 22 megawatts (MW) of electrical power using redundant feeders.
- The site had to be located at least 32 km (20 miles) from a nuclear reactor or other nuclear fuel facility and at least 8 km (5 miles) from a military munitions depot or large chemical facility that makes or stores hazardous materials.



LEGEND

1 WINNSBORO
2 OAK GROVE
3 DELHI
4 GIBSLAND
5 COLUMBIA
6 RINGGOLD
7 ARCADIA
8 HOMER
9 MINDEN
10 RAYVILLE
11 TALLULAH
12 BASTROP
13 RUSTON
14 SPRING HILL
15 PLAIN DEALING
16 SHREVEPORT
17 VIVIAN
18 OIL CITY
19 ARMISTEAD
20 FARMERVILLE
21 LAKE PROVIDENCE

Figure 2.6 Candidate Communities in Northern Louisiana (LES, 1994a)

Table 2.1 Reasons Why Candidate Communities were Eliminated During First Phase of the Intermediate Screening Process (LES, 1994a)

Community	Reason for Elimination
Rayville	Poor site configuration
Tallulah	Unstable soils; flood-prone
Bastrop	Existing large paper mill
Ruston	Academic community; not manufacturing oriented
Spring Hill	Existing large paper mill
Plain Dealing	Not within LP&L service area
Shreveport	Urban area; high land costs
Vivian	Not within LP&L service area
Oil City	Not within LP&L service area
Armistead	Not within LP&L service area; flood-prone
Farmerville	Lacks a cohesive leadership group; not manufacturing oriented
Lake Providence	Unstable soils; flood-prone

- The site had to be located within 72 km (45 miles) of Interstate 20.
- The site had to be free of documented fault zones and have stable soil suitable for an industrial site.

"Wants" were those criteria deemed desirable for an alternative to meet. LES site evaluation personnel assigned a weighting factor for each "want" that ranged from 1 to 10, depending on the factor's relative importance. Then each community was given a score from 1 to 10 on how well the community satisfied the "want." The community selected is the community which had the highest total score. The "wants" or desirable criteria were:

- local support conducive to operation of the facility
- an active and cohesive community leadership to facilitate development of the site
- availability of technically-trainable personnel
- located in an area where LES would not have to compete with other industrial facilities for employees or community services
- a livable community for the local workers

- located within a reasonable driving or commuting distance to a metropolitan area

- a community with a manufacturing mentality

- minimal land cost

- located in an area where maintenance services are already available

- a site where financial incentives are offered

All nine candidate communities met the "must" criteria. Total scores were essentially the same for all communities with the three highest scores for the Homer, Winnsboro, and Delhi communities, respectively (Table 2.2). Homer was selected because it was the highest-rated community, with Winnsboro as the backup.

2.3.1.3 Potential Sites Around Homer, Louisiana

Six potential sites around Homer, Louisiana were identified for further evaluation (Figure 2.7). These sites are hereafter referred to as the Prison site, the Emerson site, the LeSage site, Baptist Children's Home, the Gladney site, and the King site. Eight selection criteria, including one "must" criterion, were used to analyze and compare these sites in a final screening process. The eight selection criteria were:

- low flood risk (a "must" criterion); above 100-yr floodplain

- the preference of community leaders

- condition of the State highways that access Interstate 20

- low population within a 3-km (2-mile) radius

- at a distance of at least 8 km (5 miles) from institutions such as schools, hospitals, and nursing homes

- total cost of land

- site having an approximate square shape

- topography promoting efficient site drainage

The results of this comparative analysis using the weighted score method are presented in Table 2.3. Only one of the six potential sites, Baptist Children's Home, was eliminated for failing to pass the "must" criterion. The three sites that had the highest total scores were the LeSage site, the Emerson site, and the Prison site, respectively.

Table 2.2 The Results of the Second Phase of the Intermediate Screening Process

	Weight	Winnsboro		Oak Grove		Delhi		Gibsland		Columbia		Ringgold		Arcadia		Homer		Minden	
		Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*
LP&L Electric Service	Must	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Facility Dimensions	Must	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Proximity to I-20	Must	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Geologic/Soil Conditions	Must	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Local Support	10	10	100	10	100	8	80	7	70	7	70	8	80	10	100	9	90	9	90
Opinion Leader Unity	10	10	100	10	100	8	80	6	60	7	70	4	40	7	70	10	100	8	80
Availability of Operational Personnel	10	9	90	6	60	9	90	7	70	7	70	8	80	9	90	10	100	10	100
LES Position as Dominant Industry	9	10	90	10	90	8	72	10	90	7	63	10	90	10	90	8	72	3	27
Livability	9	8	72	5	45	10	90	6	54	7	63	4	36	7	63	9	81	9	81
Distance to Metro Area	8	6	48	5	40	8	64	10	80	8	64	10	80	9	72	9	72	10	80
Manufacturing Mentality	7	10	70	5	35	10	70	5	35	8	56	5	35	7	49	10	70	10	70
Land Costs	6	9	54	10	60	10	60	6	36	9	54	6	36	4	24	8	48	8	48
Availability of Maintenance Services	6	7	42	5	30	8	48	10	60	7	42	8	48	10	60	8	48	8	48
Incentives	5	10	50	8	40	8	40	7	35	8	40	8	40	8	40	10	50	9	45
Total Scores			716		600		694		590		592		565		658		731		669

*Weighted Score = Weight x Score

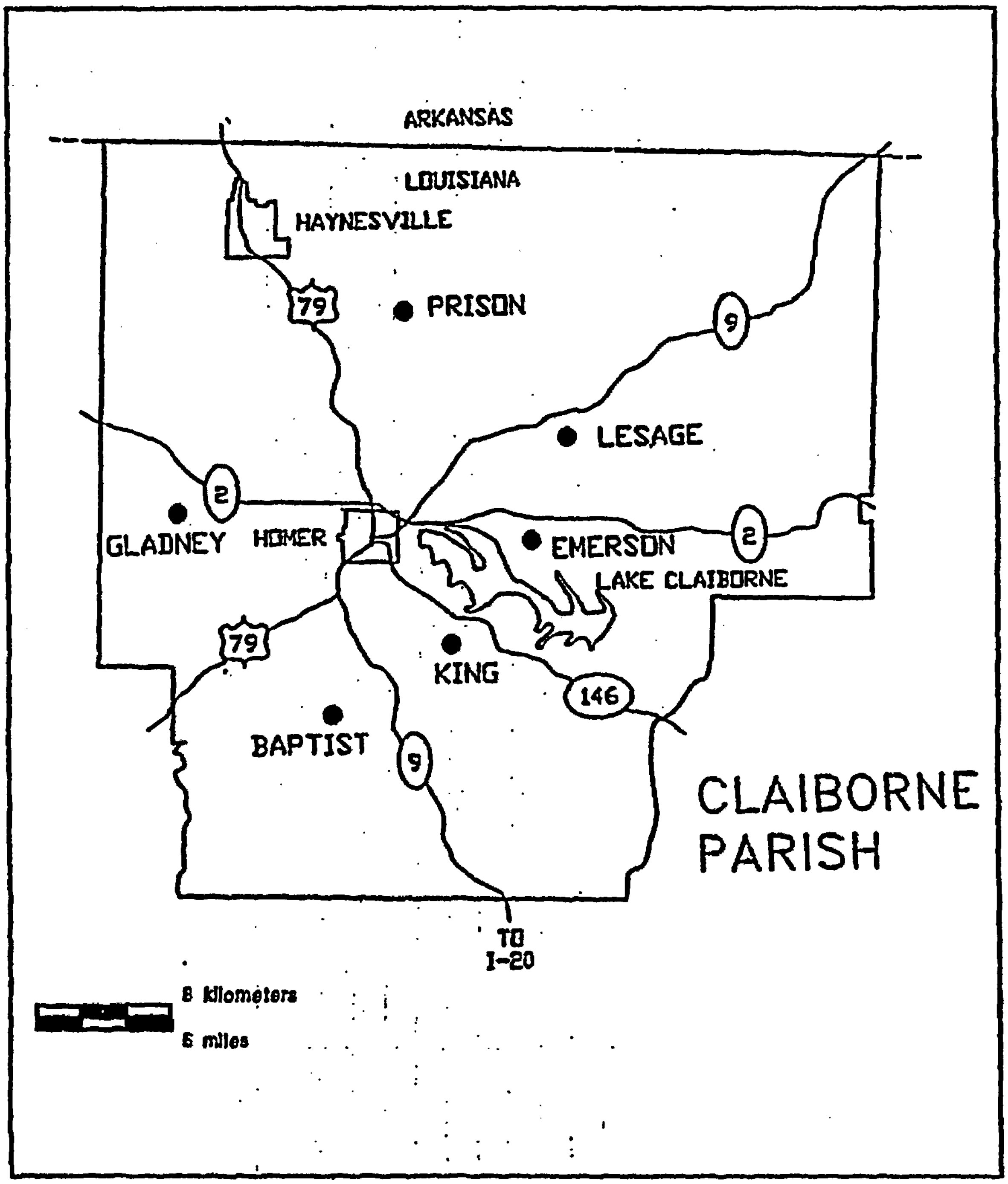


Figure 2.7 Potential Sites Near Homer, Louisiana (LES, 1994a)

Table 2.3 Fine Screening Analysis of Six Sites within Homer Community (LES, 1994a)

Criteria	Weight	Prison Site		Emerson Site		LeSage Site		Baptist Children's Home		Gladney Site		King Site	
		Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*
Low Flood Risk - Out of 100 Year Floodplain	Must	Yes	OK	Yes	OK	Yes	OK	No	Drop	Yes	OK	Yes	OK
Community Leader Preference	10	10	100	9	90	9	90			2	20	0	0
Good State Highway Access	8	8	64	10	80	10	80			10	80	8	64
Low Adjacent Population	8	10	80	7	56	9	72			9	72	7	56
Institutions within 5 miles	8	5	40	8	64	9	72			9	72	7	56
Total Land Price	5	10	50	8	40	9	45			5	25	8	40
Site Shape	4	8	32	10	40	10	40			10	40	10	40
Topography of Site	4	3	12	8	32	10	40			10	40	10	40
Total Scores			378		402		439				349		296
Comments				Good layout close to highway		Good flat spot in middle of site along road		Drop due to site being partially in 100 year floodplain					

*Weighted Score = Weight x Score

Following this phase of the fine screening process, the three highest-rated sites were examined further to complete the selection process. In this last phase, LES performed preliminary geotechnical investigations at the three sites and collected environmental and site-specific characteristics information to aid in determining the preferred site that was most acceptable for the LES proposed action.

The information collected was used to assess the following:

- suitability of site for construction and operation
- extent of potential remedial actions needed
- grading requirements and corresponding costs
- electric power connection costs
- previous land uses at the site
- proximity of the site to national and State forests, wetlands, wildlife, and areas of scenic, historical, or archaeological significance
- LP&L estimates
- site preparation and grading costs
- preliminary geotechnical evaluation results that will determine the suitability of the site for construction and operation

The results of the assessments were incorporated into the analysis performed in Table 2.3 and the resulting weighted score analysis is provided in Table 2.4. All three potential sites were adequate sites for accommodating the proposed facility. However, because it received the highest total score rating, the LeSage site was proposed by LES for the construction and operation of the CEC.

Many individuals who commented on the DEIS noted that the proposed CEC site is adjacent to two minority communities. Some commentors alleged that LES deliberately chose the site for this reason. The NRC acknowledges that the proposed site is near two minority communities, however, the staff found no evidence to support the allegation that LES chose the site for this reason. Further discussion of environmental justice is included in Section 4.2.1.7.4. Although other criteria and methods could be used in a selection process, the NRC staff concludes that the LES approach for selecting the site was reasonable.

Table 2.4 Weighted Score Analysis of Three Preferred Sites Near Homer Community During the Final Screening Process (LES, 1994a)

		Site					
		Prison Site		Emerson Site		LeSage Site	
Criterion	Weight	Score	Weighted Score*	Score	Weighted Score*	Score	Weighted Score*
Above 100-Year Floodplain	Must	Yes		Yes		Yes	
Preferences of Community Leaders	10	10	100	9	90	9	90
Property Contamination Mitigation	8	8	64	8	64	10	80
Preliminary Environmental Survey	8	9	72	10	80	10	80
Good State Highway Access	8	8	64	10	80	10	80
Low Adjacent Population	8	10	80	7	56	9	72
Distance from Institutions	8	5	40	8	64	10	80
Cost of Land	5	10	50	8	40	9	45
Cost of Providing Electricity	5	10	50	6	30	7	35
Sitework and Grading Costs	5	6	30	9	45	10	50
Preliminary Geotechnical Evaluation	5	7	35	10	50	10	50
Site Shape	4	8	32	10	40	10	40
Topography of Site	4	3	12	8	32	10	40
TOTAL SCORE	-		629		671		742
Comments	-	Ravine/wetland down middle of site		Good layout close to highway		Good flat spot in middle of site along road	

**Weighted score = Weight x Score*

2.3.2 Site Preparation and Construction

The construction of the CEC will take place over 6 years and the facility will be fully operational in 7 years. The construction activities have been categorized into the areas of site development, facility construction, and utility acquisition. During the construction phase, LES plans to employ mitigating measures to minimize noise, air, and water pollution (LES, 1994a).

2.3.2.1 Site Development

Site development for the CEC involves the clearing of small trees and brush in the area of the facility, and the movement of soils (cutting, filling, and grading) to prepare a suitable surface for the CEC and its foundations. This site development, which will modify the local topography and influence future runoff from the site, will involve the use of earthmoving equipment.

The CEC site is approximately 179 hectares (442 acres), but only about 28 hectares (70 acres) of recently cleared, mixed regrowth pine and hardwood forest land will be directly affected by the construction activities. This area, which will be cleared and graded, will constitute the "controlled access area." The controlled access area is defined in NRC regulations, 10 CFR Part 73, as the area that is clearly demarcated, has controlled access, and affords isolation of the material or persons within it. The area where the buildings are to be constructed will be leveled to an elevation of about 99 meters (m) [325 feet (ft)] above mean sea level (MSL). In addition, the area will be graded so that all of the area under construction will be drained to the Hold-Up Basin, which will be located just upstream of Bluegill Pond (Figure 2.8). The Hold-Up Basin will trap suspended material in the surface water runoff during construction.

Also associated with site development, Parish Road 39, which connects the neighboring communities of Forest Grove and Center Springs, will be rerouted to pass to the west of the plant area. LES has indicated that this relocation will be performed by the Claiborne Parish Police Jury (LES, 1994a). Approximately 5.7 hectares (14 acres) of timberland will be used to relocate this road. The existing Parish Road 39 will not be closed until the relocated road is fully constructed and open. This action will not lead to relocation of residents or communities.

Figure 2.8 shows the area that will be cleared during the construction phase and the location of the Hold-Up Basin. It also shows the planned location of the new Parish Road 39.

The site earthwork will occur over a 5- or 6-month period. Up to 21 pieces of earthmoving or earthworking equipment and 5 pieces of support equipment may be used during this timeframe (LES, 1994a).

The amount of material to be removed (cut) from locations on the site is very close to the amount of material that must be added (filled) to other areas of the site. The estimated amount of material to be cut is 310,409 m^3 (406,000 yds^3), while the estimated amount of fill material is 327,229 m^3 (428,000 yds^3). Additional fill will be secured from offsite sources.

The number of construction and operating personnel needed during the early years of the project has been estimated by LES and is presented in Table 2.5.

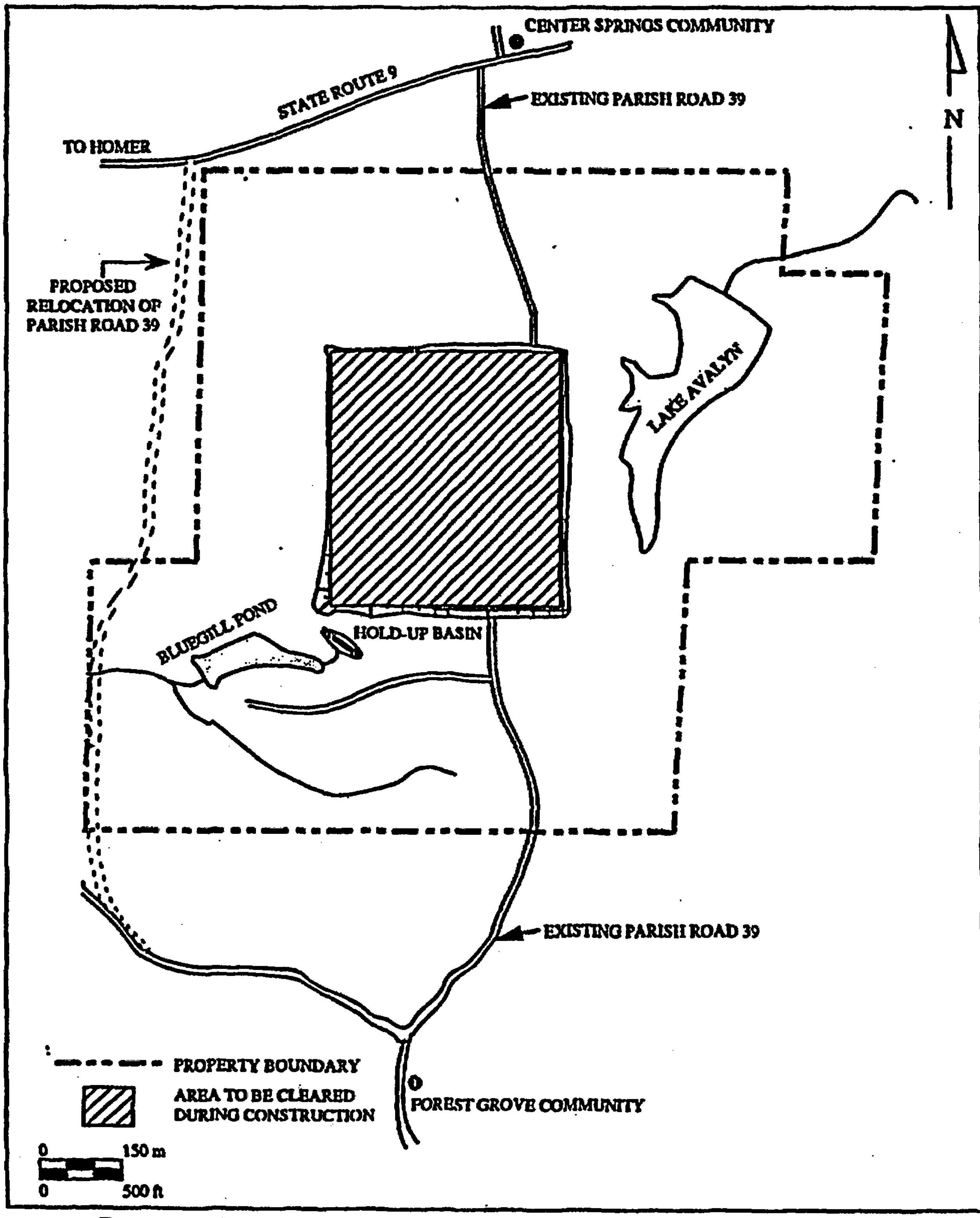


Figure 2.8 The CEC Site Layout Showing the Cleared Area and Proposed Relocation of Parish Road 39 (LES, 1994a)

Table 2.5 Projected Personnel Requirements During Construction and Operation of the CEC (LES, 1994a)

Year	Average Number of Construction Personnel Required	Average Number of Operations Personnel Required	Total Number of Personnel Required
1	25	0	25
2	150	10	160
3	300	120	420
4	400	145	545
5	250	180	430
6	80	180	260
7	0	180	180

Environmental protective measures to be taken during the construction phase (LES, 1994a) include the following:

- Noise reduction measures will be implemented, such as using mufflers on construction equipment, using tree-lined fringes, and performing construction activities only during daylight hours.
- Erosion and slumping will be minimized by developing and following a soil and erosion control plan. This plan will involve the use of internal and external diversions, incremental clearing, temporary and permanent grassing, mulching and matting, silt fences, sediment traps, and check dams.
- Spills of hazardous materials will be minimized by developing and implementing a Spill Prevention and Control Plan that will identify sources, locations, and quantities of potential spills, and response plans for potential spills. The Plan will identify specific individuals responsible for both implementing the plan and dealing with regulatory authorities.
- Dust generation will be minimized through a combination of measures that are applicable to specific construction situations, such as wetting dirt roads and cleared and graded areas and spreading construction areas with water, using containment methods for sandblasting or similar operations, covering truck bodies when transporting potentially dusty material, promptly removing dirt or other dusting material from paved roads, and promptly

re-vegetating or covering bare areas once earthmoving activities have been completed.

- Chemical contamination potential will be minimized since LES does not plan to use herbicides, growth retardants, or chemical sprays during clearing operations.

2.3.2.2 Plant Design and Layout

The CEC will be designed and constructed to consider site-specific factors and to meet the design criteria specified in the NRC regulations for uranium facilities (10 CFR Part 76) advance notice of proposed rulemaking (NRC, 1988a). These criteria include the characteristics of Design Basis natural phenomena events. The CEC is designed to minimize impact to buildings from rainfall; cyclonic wind storms, such as tornados and hurricanes; lightning; and seismic events.

Construction of the buildings at the CEC is scheduled to begin in parallel with site preparation. LES has stated that construction precautions will be instituted to minimize environmental impacts (LES, 1994a). The major buildings to be located at the CEC are: the Separations Building, where uranium will be converted to liquid and gaseous forms, enriched, and then recovered to solid form; and the auxiliary buildings where uranium will not be handled in gaseous or liquid forms (Figure 2.9). The Separations Building is designed to withstand the following Design Basis Tornado:

• Design Wind Speed (gust)	210 km/hr
• Design Wind Speed (fastest-mile)	180 km/hr
• Radius of Damaging Winds	70 m
• Atmospheric Pressure Change	1915 Pa
• Atmospheric Pressure Rate	958 Pa/sec

None of the auxiliary structures are designed to withstand these parameters since failure of these structures will not jeopardize CEC operational safety. The CEC buildings incorporate Standard Building Code precautions to protect against lightning. The CEC area averages 2.1 lightning flashes/km^2 annually.

The Separations Building is designed to withstand the Design Basis Earthquake. The Design Basis Earthquake for the CEC site and vicinity has a peak bedrock horizontal acceleration of 0.45 m/s^2 (0.046 g_a) and a peak vertical acceleration of 0.32 m/s^2 (0.033 g_a).

The gaseous effluent vent stacks will be 36.6 m (120 ft) in height and are designed to withstand the wind and differential pressure effects of the Design Basis Tornado and the Design Basis Earthquake. In addition, the Switch Yard is located away from the Separations Building to eliminate potential serious impacts as a result of any failure.

Figure removed under 10 CFR 2.390.

A floor plan of the Separations Building is given in Figure 2.10. The Separations Building will comprise the following areas:

- The centrifuges and the actual enrichment process will be located in the Cascade Halls. There will be two assay units per Plant Unit, and seven cascades per assay unit. Each Cascade Hall will house a single assay unit.

- Waste will be collected and treated, equipment will be decontaminated, laboratory analysis will be performed, and health physics services will be housed all in the Technical Services Area (TSA).

- All uranium will enter and exit the building through the Cylinder Handling Area, which will be located in the southeast corner of the Separations Building. Within the area, measuring about 39.6 m by 16.5 m (130 ft by 54 ft), an overhead crane will position feed cylinders onto a rail transporter, put them in temporary storage, or place them on a weigh station.

- The UF_6 Handling Areas are where: 1) the natural UF_6 will be cold purified, heated to a liquid and hot purified, vaporized, and fed into the centrifuge enrichment cascades; 2) the enriched uranium will be withdrawn from the cascades and desublimed (converted from the gaseous state to the solid state); 3) the depleted uranium will be withdrawn from the cascades and desublimed and the contingency dump system will be maintained; and 4) the product UF_6 will be sampled.

- The Auxiliary Areas will be located on the south end of each Plant Unit. Each Auxiliary Area will contain the plant cooling water system, the machine cooling water system, the spray cooling water system, the hot refrigerant system, and the cold refrigerant system.

- The Electrical Distribution and Heating, Ventilation, and Air Conditioning (HVAC) Equipment Areas will be located between the Cascade Halls and the UF_6 Handling Areas. The electrical distribution and management equipment will be located on the ground level, and the HVAC equipment will be located on the second level.

- The Product Blending Facility will be located in the common area of the Separations Building and will measure approximately 21.3 m by 27.4 m (70 ft by 90 ft). This area will be used to blend the contents of two cylinders to adjust the ^{235}U content.

- The Utility Area will be located near the southeast corner of the building between the Cylinder Handling Area and the Auxiliary Area supporting

Figure removed under 10 CFR 2.390.

Plant Unit 1, and will contain storage vessels for demineralized water, the refrigerant supply system, the plant and instrument air system, the hot water system, and part of the gaseous effluent vent system.

The Separations Building will be about 141 m by 229 m (463 ft by 751 ft) and about 13.7 m (45 ft) high. The building will be constructed of precast/prestressed concrete columns and beams. Poured-in-place concrete toppings will be used on the roof surfaces. The roof over the Cascade Halls will have a 5-centimeters (cm) (2-in) concrete topping, while the roof over the Cylinder Handling Area, the Utility Area, and the Product Blending Area will have a total roof thickness of 16.5 cm (6.5 in) of concrete. The roof over the TSA will be topped with 5 cm (2 in) of concrete.

The external walls of the Separations Building, with the exception of the TSA, will be solid precast/prestressed concrete panels that are 20 cm (8 in) thick. The two external walls of the TSA will be precast/prestressed concrete panels 15 cm (6 in) thick.

The structural steel to be used in the Separations Building will be fabricated and erected in accordance with the American Institute of Steel Construction Code of Standard Practice. The welding of this steel will be performed by welders who are certified according to the requirements of the American Welding Society Structural Welding Code and who use procedures qualified in accordance with the same code. The reinforced concrete structures are designed to meet the requirements of the American Concrete Institute, Building Code Requirements for Reinforced Concrete, ACI-318-89.

The auxiliary buildings to be located at the CEC include the following:

- The Centrifuge Assembly Building will be located north of the Separations Building and is where centrifuges will be assembled and mechanically tested prior to installation in the Cascade Halls inside the Separations Building.

- The Cylinder Receipt and Dispatch Building is where empty cylinders will be received and tested and where full cylinders containing either feed, product, or tails will be inspected, weighed, and then dispatched to processing, customers, or storage. The Cylinder Receipt and Dispatch Building will measure approximately 30.5 m by 15.3 m by 10 m (100 ft by 50 ft by 33 ft) high. The building will have a braced-steel frame enclosed with insulated metal siding.

- The Office Building and Security Station will house both the facility office staff and the security staff. The office portion of the Office Building and Security Station will be about 30.5 m by 38 m by 7.6 m (100 ft by 125 ft by 25 ft) high, while the security portion of the building will be about 7.6 m

by 10.7 m by 3.7 m (25 ft by 35 ft by 12 ft) high. The building will be a steel-framed structure with parapet walls.

- The Standby Diesel Generator Building will contain two diesel generators that will provide emergency backup power to the CEC and to the associated day tanks, switch gear, and control panels. The building will be approximately 22.8 m by 12.2 m by 7.6 m (75 ft by 40 ft by 25 ft) high. The building will be constructed of precast concrete panels and will have a roof constructed of concrete T-beams.

- The Pump House will be located between the two proposed water wells. It will measure about 14 m by 11.9 m by 3.7 m (46 ft by 39 ft by 12 ft) high and it will contain pumps for supplying firefighting water and potable water, as well as a water treatment system.

- The Sewage Treatment Plant will be located in the southeast corner of the site. It will be used to treat the facility's wastewater and then discharge it through the NPDES outfall.

These auxiliary buildings are designed to meet the requirements of the Southern Building Code Congress International, Inc., Standard Building Code.

Construction of the buildings at the CEC is expected to start in 1995. Construction equipment and materials will arrive at the site by truck. During the peak construction phase, the applicant has estimated that daily traffic will consist of the following:

- five to ten trips to obtain construction materials (wood, concrete, structural and sheet metals, piping, etc.)

- five to ten trips of supplies (paint, oil, fuels, cleaners, valves, hoses, conduits, pipes, wire, cable, etc.)

- two to three trips of tools and equipment (welders, chain hoists, scaffolds, drills, wrenches, ladders, etc.)

- five to ten trips of concrete trucks during periods of concrete placing

- five to ten trips of light duty trucks (vendors)

In addition, during the peak construction phase (1997 - 1998) it is expected that 300 to 400 private automobiles owned by construction workers will access the site and 145 operational personnel will drive to the site. Most of the traffic will be coming toward the site in the morning (between 5 a.m. and 7 a.m.) and going away from the site in the evening (between

4 p.m. and 6 p.m.). Traffic patterns to and from the site are expected to be equally distributed east and west on Highway 9.

2.3.2.3 Utility Acquisition

Two major utilities are required to operate the CEC: electricity and water. Twenty-two MVA of electricity will be required primarily to operate the centrifuges, uranium gas compressors, cylinder heaters, refrigerant compressors, and water pumps. LP&L will run two 115-kilovolt (kV) overhead power lines into the site. The first will come from a substation located near Haynesville, approximately 19 km (12 miles) northwest of the CEC, and the second will come from a substation located near Bernice, approximately 27 km (17 miles) east of the CEC. The right-of-way areas for the Haynesville power line and the Bernice power line are estimated to be approximately 58 hectares (143 acres) and 86 hectares (212 acres), respectively.

Water will be supplied to the site and will be used for drinking, plant and machine cooling, and firefighting. Water will be supplied by two wells planned to be drilled into the Sparta Aquifer. Only one well will be operated at a time during normal operations, but both wells can be operated simultaneously, if necessary.

2.3.2.4 Resource Requirements and Waste Generation

In addition to the equipment and shipments that will be associated with the construction of the CEC, some resources will be used and waste will be generated.

During construction, a variety of materials and resources will be used. Estimated quantities of several of these resources are listed in Table 2.6.

Table 2.6 Estimated Quantities of Resources Used During Construction (LES, 1994a)

Resource	Estimated Quantity Used During Construction
Water	2,271,247 liters (600,000 gallons)
Concrete	30,582 m^3 (40,000 yds^3)
Steel	4,535,000 kg (5,000 tons)
Aluminum	4,535,000 kg (5,000 tons)
Fuel, Gasoline	567,812 liters (150,000 gallons)
Fuel, Diesel	681,374 liters (180,000 gallons)
Oil	7,571 liters (2,000 gallons)
Fill Soil	17,000 m^3 (22,000 yds^3)

Wastes expected to be generated during construction will consist of nonhazardous materials such as scrap lumber, paper, and packing material. These wastes will be disposed offsite in an approved manner in a landfill. Construction activities are estimated to generate an average of 3,058 m^3 (4,000 yds^3) noncompacted, conventional waste annually. Table 2.7 presents estimated amounts of hazardous waste that may be generated during construction activities which include moving dirt, operation of heavy equipment, and installing buildings and equipment. Sources of this type of waste are paints, solvents, batteries, mercury vapor lights, and pesticides.

Text removed under 10 CFR 2.390.

Management and disposal of these wastes will be handled by a staff of two people who are professionally trained to identify, store, and transport wastes; are audit vendors; conduct spill cleanup; maintain inventories; prepare annual reports; and interface with State regulatory agencies. LES will dispose of hazardous waste in accordance with State and Federal requirements (LES, 1994a).

2.3.3 Description of Operation

The CEC will produce various grades of low-enriched uranium (ranging up to 5 weight percent ^{235}U) using the gas centrifuge process. The CEC will convert natural uranium hexafluoride (UF_6) feed (0.71 weight percent ^{235}U) into enriched uranium product (2 to 5 weight percent ^{235}U) and depleted uranium tails (nominally 0.2 to 0.3 weight percent ^{235}U). In simple terms, the gas centrifuge process involves the transfer of gaseous UF_6 under vacuum (except for the short distance where it is pressurized within the autoclave) from a feed cylinder, through the centrifuge cascades where the enrichment occurs, and into product and tail cylinders. The feed cylinders containing natural uranium in the form of solid UF_6 are heated to produce gas. Vacuum pumps are used to move the enriched uranium and depleted uranium through the centrifuge cascades and into the product and

tail cylinders, as appropriate, where the product and tails are allowed to cool to form solid UF_6.

The major steps in the operation of the CEC are: feed receipt and storage, feed purification and vaporization, enrichment, product and tails removal, product blending, product storage and shipping, and tails storage. A flow diagram depicting the uranium enrichment process is presented in Figure 2.11.

As shown in Figure 2.10, the Separations Building will have three Plant Units. Each Plant Unit will house feed, enrichment, and product and tails withdrawal processes, and will contain the unit's process heating and cooling equipment. Each Plant Unit will be able to operate independently of the other two Plant Units, while interconnections between Plant Units will provide redundancy. Blending, sampling, waste management, and laboratory equipment support all three Plant Units. Within each Plant Unit, the enrichment function is divided into cascades and assay units. A cascade is an arrangement of multiple centrifuges which can provide a selected ^{235}U product assay. A cascade comprises approximately 1,000 centrifuges. Seven cascades are grouped into an assay unit and two assay units are located in each Plant Unit. Thus, the CEC will comprise 3 Plant Units, 6 assay units, and 42 cascades; and will contain a total of approximately 40,000 centrifuges.

In addition to the process steps, the Centrifuge Assembly Building (CAB) is also briefly discussed.

2.3.3.1 Feed Receipt and Storage

The CEC will receive solid UF_6 containing approximately 0.71 weight percent ^{235}U under partial vacuum in 122-cm (48-in.) diameter carbon-steel cylinders. The feed cylinders will contain up to 12,512 kg (27,560 lbs) of UF_6 and are constructed in accordance with ANSI-N14.1, an internationally-accepted standard for the design, fabrication, and testing of cylinders used to transport and store UF_6. Feed cylinders will be delivered by truck to the Cylinder Receipt and Dispatch Building, where they will be unloaded by a 23-metric ton (25-ton) crane, inspected, and weighed. After the integrity and physical inventory of each cylinder has been verified, a mobile transporter will move individual cylinders to the Product and Feed Storage Area for temporary storage. This storage area will hold approximately 187 feed cylinders, which is equivalent to a 6-month supply of feed. Feed cylinders will be stored at ambient temperatures on concrete blocks and will be spaced one every 12.3 m^2 (132 ft^2). The CEC will be equipped with an unloading dock, crane, pressure testing station, cylinder evacuation station, and a 23-metric ton overhead traveling crane for loading and unloading road vehicles. An office will be provided for checking the identity of cylinders and for processing supporting documentation.

When feed material is required in the Separations Building, a mobile transporter will move feed cylinders from the Product and Feed Storage Area to the Separations Building. A cylinder containing UF_6 will be transported only when the feed is in solid state and at temperatures below 53.9° C (129° F).

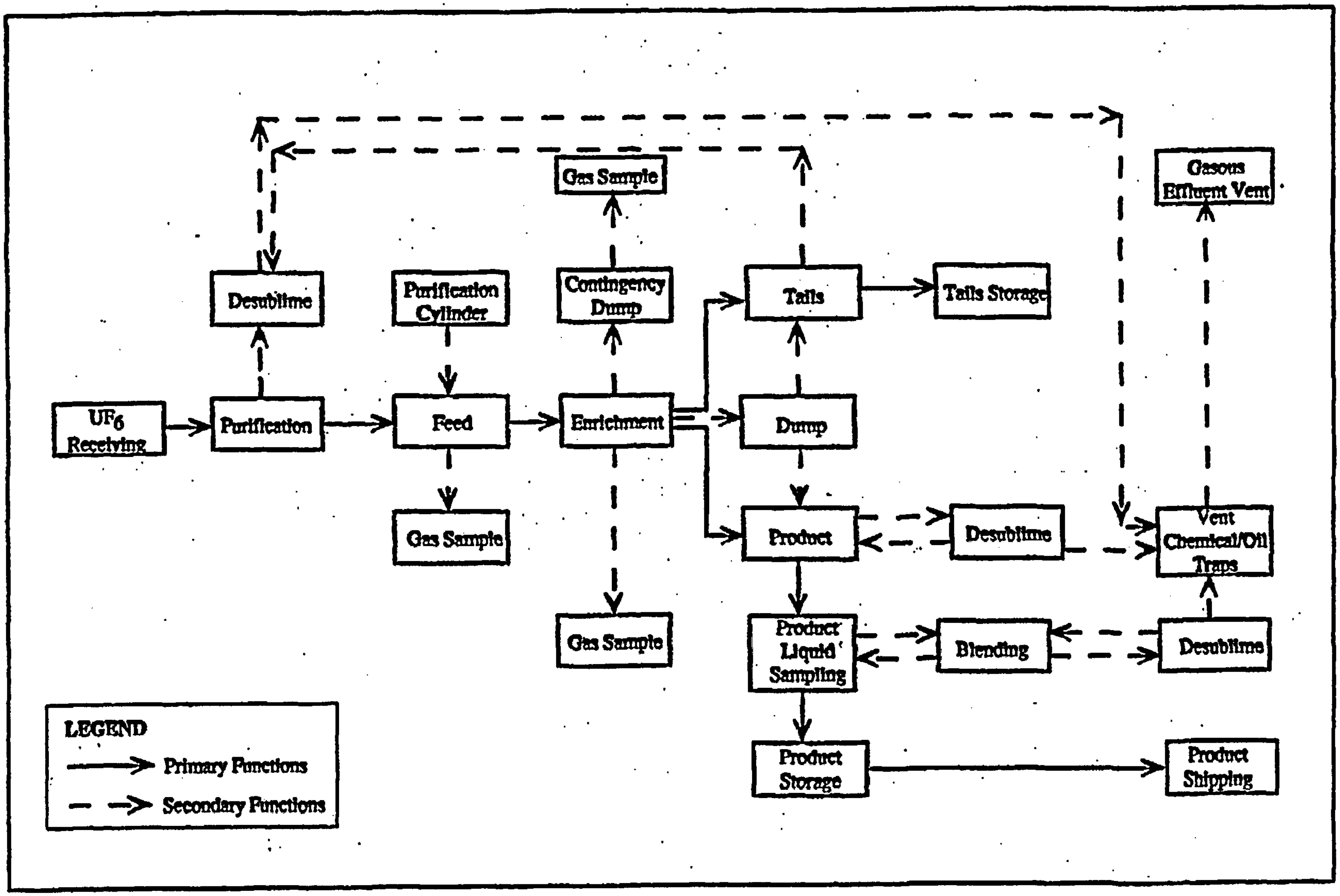


Figure 2.11 Flow Diagram of the CEC Uranium Enrichment Primary and Secondary Process Functions (LES, 1993a)

2.3.3.2 Feed Purification and Vaporization

In the Separations Building, a crane will place the cylinder on a cradle and load the cylinder and the cradle onto a rail transporter. The rail transporter will travel the length of the Separations Building on rails and deliver the cylinder and cradle to a feed autoclave. An autoclave is a horizontally-mounted, cylindrical vessel, fitted with a door and internal piping, which is used to heat, liquify, and vaporize UF_6. Internal autoclave piping will connect the cylinder to the balance of the enrichment system. Each autoclave will be provided with process control and safety protection systems which monitor and control cylinder and autoclave temperature and pressure. Each feed autoclave will be equipped with a weighing system that allows continuous monitoring of the quantity of UF_6 contained in the cylinder.

Feed cylinders will be placed in autoclaves for UF_6 purification and feed gas generation. Before the UF_6 is introduced into the Enrichment System, the UF_6 must be purified by venting the cylinders to remove light gases such as oxygen, nitrogen, and hydrogen fluoride (HF). This will be accomplished in two purification steps. The initial step is called cold purification and will involve venting the cylinder while the UF_6 is solid (ambient temperature). During cold purification, the feed autoclave door will be left open to automatically disable the feed autoclave heater and prevent inadvertent heating of the cylinder. The vented light gases will pass through a desublimer and chemical traps to remove uranium and HF before being released to the Gaseous Effluent Vent System (GEVS). The desublimer will be a steel tube in which UF_6 is condensed from the vapor state to the solid state or vaporized from the solid state to the vapor state. The change of phases is produced by passing cold or hot heat transfer fluid through coils wrapped around the desublimer tube. This purification process is repeated until the desired purity is achieved. The GEVS will provide final assurance of contaminant control by filtering the vent gases through HEPA and activated carbon filters before releasing the gas to the atmosphere.

The second step is called hot purification and will involve heating the UF_6 cylinder until the contents have been liquefied. The UF_6 will be liquified by heating the exterior of the feed cylinder with hot air within the autoclave. The temperature of air will be controlled to maintain specific cylinder pressure as the UF_6 liquifies. The cylinder again will be vented to the desublimer to remove light gas contaminants which may have been trapped in the solid UF_6. Typically, only one hot purification cycle is performed for each cylinder. Once the desired purity has been reached, the feed cylinder vent valve will be closed and the cylinder will be maintained in a standby mode with the UF_6 still in the liquid state.

After feed purification, a valve in the line from the cylinder to the cascade will be opened and gaseous UF_6 will flow from the cylinder to the cascade. The UF_6 feed cylinder temperature and pressure will be controlled during the feed cycle. The UF_6 gas will be above atmospheric pressure when it leaves the cylinder, but will be passed through a motor-operated pressure reduction valve located inside the autoclave. UF_6 pressure will be

subatmospheric in the feed lines outside of the autoclave. When the contents of the feed cylinder are nearly removed, another feed cylinder inside another autoclave will be brought online to supplement the decreasing flow of UF_6 from the original feed cylinder, thereby maintaining a continuous feed flow to the Enrichment System.

When the feed cylinder is almost empty, it will be isolated from the feed header. The cylinder will then be vented to the purification desublimer to evacuate as much residual UF_6 (cylinder heel) as possible. After removal of the residual UF_6, the cylinder will be allowed to cool.

When the desublimer reaches its UF_6 operational fill limit, it will be heated by freon supplied by a hot refrigerant system to sublime the trapped UF_6 for gaseous transfer and collection in a feed purification cylinder. The gaseous UF_6 recovered will be desublimed by spraying the cylinder with cool water at 4 °C (39 °F). Cooling water will be supplied by a spray cooling water system.

2.3.3.3 Enrichment

The Enrichment System will receive natural UF_6 (i.e., 0.71 weight percent ^{235}U) from the feed system and separate it into the product and tails streams using the centrifuge process. It will furnish product streams ranging up to 5.0 weight percent ^{235}U and tails streams ranging from 0.20 to 0.34 weight percent ^{235}U.

In each of the three CEC Plant Units, UF_6 will be fed at subatmospheric pressure from the feed autoclaves through feed headers to two assay units, each consisting of seven centrifuge cascades. UF_6 will be fed into each centrifuge near its axis. Centrifugal force will cause the heavier ^{238}U isotope to move toward the wall of the centrifuge, which will effectively increase the ^{235}U concentration near the center. A counter current flow produced by an axial temperature gradient will help move the enriched gas fraction to the Product Take-Off System tube. A control valve will regulate the flow of the product, thus ensuring a proper level of enrichment.

The nominal separative work capacity of the CEC is 1.5 million SWU per year. At this limiting level of separative work, the CEC may produce a given quantity of product UF_6 at low ^{235}U enrichment or a lesser quantity of product UF_6 at a higher ^{235}U enrichment. Nominal flow rates for the low (maximum flow) enrichment case are presented in Table 2.8.

2.3.3.4 Product and Tails Removal

Product Removal

Enriched gaseous UF_6 will be continuously withdrawn from the Enrichment System by the Product Take-Off System and transferred to product cylinders in the UF_6 Handling Area. A train of vacuum pumps, installed in two stages, will control the withdrawal of the UF_6

Table 2.8 Maximum Nominal Continuous Flow Rates (LES, 1994a)

Assay Unit	Plant Unit 1		Plant Unit 2		Plant Unit 3	
	A	B	C	D	E	F
Product assay, wt%	2.0	2.5	2.5	2.5	2.5	2.5
Feed, kg/hr	135	117	117	117	117	117
Product, kg/hr	30	20	20	20	20	20
Tails, kg/hr	105	97	97	97	97	97

product from the Enrichment System. The first stage will compress the gaseous enriched UF_6 from the centrifuge cascade primary pipe headers through a secondary pipe header. The second stage will compress the gaseous UF_6 from the secondary pipe through a tertiary pipe header. The compressed gas will then be transferred to product cylinders where it is desublimed (solidified) by indirect air cooling. In each of these process steps, UF_6 gas pressure remains subatmospheric.

A set of five product cylinder stations will be dedicated to each assay unit to receive the enriched UF_6 product, but only three cylinder stations will be used at one time. The piping between the second stage vacuum pump and the cylinder stations will be heat traced to prevent blockage due to UF_6 desublimation. Valves located on the pipes will be enclosed in hot boxes to negate blockage.

Each product cylinder (30B type cylinder) has a maximum UF_6 capacity of 2,282 kg (5,020 lbs). Cylinder weight and pressure will be continuously measured during the take-off process by on-line instrumentation systems. Light gases which enter the Enrichment System concentrate at the product removal station. The product cylinder will be periodically vented though a desublimer-vent gas trap system to remove the light gases from the product cylinder.

Tails Removal

The Tails Take-Off System will provide continuous withdrawal of depleted UF_6 from the Enrichment System. The tails streams will be transferred to the UF_6 Handling Area by two stages of vacuum pumps. In the UF_6 Handling Area, the tails will be desublimed into 122-cm (48-inch) diameter cylinders, and then water cooled. The Tails Take-Off System will rarely produce gaseous effluents; however, any effluents (light gas impurities) will be transferred to the Feed Purification Subsystem for processing, then out to the GEVS.

Cascade Dump Systems

A secondary function of the Product and Tails Take-Off Systems will be to provide a rapid means of evacuation of UF_6 from the centrifuge cascades to avoid damage to the centrifuges produced from abnormal operating conditions, such as high or low temperature, high pressure, or loss of drive to the centrifuges.

Dumping of a cascade to the Product or Tails Take-Off Systems will be effected through bypassing the cascade terminal control valve, allowing elevated flow rates of UF_6 to the product or tails cylinders. In the event of loss of electrical power or instrument air, dumping of the cascades to the Product or Tails Take-Off Systems will not be possible. In this case, the contents of the cascades may be routed to the Contingency Dump System through vacuum pumps operated from an Uninterruptable Power System (UPS). The Contingency Dump System will be comprised of multiple trains of NaF adsorbent beds, surge vessels, and vacuum pumps. One train of contingency dump equipment will be provided for each cascade. When the cascade gas is vented through this system, UF_6 will be bound to the NaF adsorbent, and the remaining light gases will be released to the GEVS.

2.3.3.5 Product Blending

The Product Blending System will provide the means by which the contents of two product cylinders can be mixed to give a final product of the desired ^{235}U enrichment. The system will consist of two autoclaves containing the donor product cylinders selected for blending, plus five receiver stations that house receiver cylinders. Four of the five cylinders will blend products, while the fifth will receive the heels from the donor cylinders and the contents from the desublimer.

Blending will be achieved by melting and vaporizing the UF_6 in two donor autoclaves, then transferring the desired amount of each assay to air-cooled receiver cylinders. Mass measurements will be used to achieve the desired mixture. Unblended heels will be collected in a heels cylinder. This process will yield intermittent radioactive gaseous effluent streams that will be filtered and vented through the GEVS.

2.3.3.6 Product Storage and Shipping System

The Product Storage and Shipping System will serve as a storage area for the sampled and blended product cylinders. The Product Storage and Shipping System will consist of the storage area with reinforced chocks for holding cylinders, mobile cylinder transporters, and a shipping dock in the Cylinder Receipt and Dispatch Building. A scale and crane will be located in this building. The product cylinders will be stored on chocks in the outdoor storage area. Cylinders will not be stacked, and adequate clearance will be provided for mobile carrier access. A cylinder will be retrieved from storage with a mobile cylinder transporter and then conveyed to the shipping dock where it will be weighed. An overhead

crane will load the cylinder onto a truck for shipping. No effluents of any kind - solid, liquid, or gas - will normally arise from this area.

2.3.3.7 Tails Storage

Tails cylinders, containing solid UF_6 under vacuum, will be carried via mobile transporter to the Tails Storage Area (TSA) (Figure 2-9). This outdoor storage area will be located south of the Separations Building and will provide spacing of 12 m^2 (129 ft^2) per cylinder. The cylinders will be supported by reinforced hardstand chocks. The cylinders will not be stacked and will be adequately spaced for loading and unloading needs.

2.3.3.8 Centrifuge Assembly

The Centrifuge Assembly Building (CAB) will be used to assemble, inspect, and mechanically test the centrifuges prior to installation in the Cascade Halls of the Separations Building. The CAB is divided into three specific areas: the storage area, the assembly area, and the building office area.

The storage area will be used to receive centrifuge parts. Delivery of these materials will be by truck, with the components stored inside standard land/sea containers. Once on the unloading platform, a 9-metric ton crane will unload the materials from the land/sea containers. The containers will then be stored in designated areas of the storage area. Cleanliness in the assembly area will be controlled by passing the containers through airlocks.

The assembly area will be used for final assembly, testing, and inspection of the centrifuges. The centrifuges will be assembled using six workstations and a central work pit. Once assembly is completed, the centrifuges will be transported through an airlock corridor to the Separations Building.

The building office area will be used to contain the main personnel entrances to the building as well as entrances to the assembly storage and assembly workshop. Also included in the building office area will be basic office space, a conference room, a break room, a storage room, and a change room. The change room will provide an area where occupants can dress in protective clothing, as required.

2.3.3.9 Transportation of Feed and Product Materials

Feed and product materials will be transported to and from the CEC by truck. The feed and product will be transported to the CEC in 48X or 48Y type cylinders that are loaded to a maximum weight of 12,501 kg (27,560 lbs) and carried two at a time on a flatbed truck. There will be approximately 187 feed cylinder shipments or 374 feed cylinders each year. The shipments are expected to come primarily from Metropolis, Illinois, which is about 800 km (500 miles) from the LeSage site.

The product material of the CEC will be transported in 30B type cylinders. A flatbed truck will transport two product cylinders at a time from the site to fuel fabrication facilities (LES, 1994a). Each product cylinder will hold as much as 2,280 kg (5,020 lbs). Approximately 380 product cylinders are expected to be shipped from the CEC each year after full-scale operations are underway. The locations expected to receive the enriched uranium product are the commercial fuel fabrication facilities in the U.S. that are located in Richland, Washington [3,380 km (2,100 miles)]; Columbia, South Carolina [1,300 km (800 miles)]; Wilmington, North Carolina [1,600 km (1,000 miles)]; Lynchburg, Virginia [1,800 km (1,100 miles)]; and Hematite, Missouri [900 km (560 miles)].

It is expected that approximately 107 metric tons of UF_6 feed and product will be transported weekly in specially designed and fabricated cylinders.

In addition to the uranium shipments to and from the CEC, there will be some transportation of other materials to the CEC to support the processing operations.

2.3.3.10 Decontamination System

The Decontamination System is designed to remove radioactive contamination from materials and equipment for reuse. All decontamination processes will be performed in the Decontamination Workshop of the TSA. Equipment disassembly may generate Fomblin Oil, hydrocarbon oil, freon, and contaminated solids. Components will also be degreased as necessary. The Vapor Recovery System serves degreaser units using Freon R-113, and solvent distillation will be provided to minimize Freon R-113 releases and solvent use. Solvent residues will be collected and transferred to the Liquid Waste Disposal (LWD) system. Decontamination will be accomplished manually or by immersion into a citric acid bath. Also, CEC will have a Contaminated Laundry System to collect, clean, dry, and inspect clothing and materials used in the Radiation Control Zones (RCZs). Wastewater from the washer will be transferred to the LWD System. The dryer in the Contaminated Laundry System will be vented to the TSA HVAC System ductwork.

2.3.3.11 Utilization of Resources

In addition to uranium, the following resources will be utilized: electric power to operate the centrifuges; water that will be used for potable water supplies, cooling water makeup, and the Fire Protection System; nitrogen that will be used for purging and venting the various lines before UF_6 is added; and diesel fuel that will be used, when necessary, to power a standby diesel generator. Other chemicals will also be required to increase the enrichment process efficiency and to decontaminate tools and equipment.

<u>Electricity</u>. Electricity will be supplied to the CEC by two 115-kV overhead distribution lines coming from the LP&L grid system. The CEC will function at a peak operating load of 22 MVA when at full capacity. The average annual energy consumption for the plant is estimated to be approximately 17 million kilowatt hours.

Water. A well water system, designed with redundancy, will supply the utility and potable water system. Water will be treated and stored. To protect against contamination, the potable water system will be segregated from utility water using backflow preventers. It is estimated that CEC will use an average of between 27 and 38 m^3 of water daily.

Nitrogen. Nitrogen will be used for purging, blanketing, and drying vessels and lines in the CEC to make sure that uranium does not react with tramp moisture in the system and get deposited on surfaces. Nitrogen will be stored onsite in a 38-m^3 (10,000-gallon) cryogenic (low temperature) storage tank.

Diesel Fuel. Diesel fuel will be used to power two standby diesel generators in the event of a power outage at the CEC. Each diesel engine will be able to produce approximately 1.5 MW of electrical power. Diesel fuel will be stored onsite in two 38-m^3 (10,000-gallon) aboveground tanks.

Sodium Hydroxide. Sodium hydroxide (NaOH) will be used to adjust the pH of the wastewater from the decontamination facility. NaOH will be brought to the CEC in solution form. Releases of NaOH would damage the vegetation in the immediate area of an unlikely spill. The Environmental Protection Agency (EPA) requires the weight reporting of a release of NaOH in excess of 450 kg (1,000 lbs). The estimated inventory is one 208-liter (55-gallon) drum of 50 percent NaOH solution (approximately 300 kg).

Sodium Fluoride. Sodium fluoride (NaF) will be used to remove UF_6 from cascades in the event of a total loss of power. NaF will be transported to the CEC in powder and pellet form. Releases of NaF could cause damage to vegetation in the immediate vicinity of an unlikely spill and to animals and humans if ingested. The estimated inventory of NaF onsite is about 5 m^3 (170 ft^3) (approximately 13,000 kg). EPA requires the reporting of NaF release in excess of 450 kg (1,000 lbs).

Citric Acid. Citric acid ($C_6H_8O_7$) will be used to decontaminate equipment. It will be transported to the CEC in granular form. Spills of $C_6H_8O_7$ may lead to pH reduction of water solutions; and if sufficient amounts are released, it could damage vegetation in the immediate area of a spill.

Chlorofluorocarbons (CFCs). CFCs were to be used to cool water and air at the CEC and to improve the enrichment process efficiency. They were also to be used as solvents for degreasing equipment. Freon R-11 had been selected as the refrigerant to be used at the CEC and Freon-113 as the degreaser. However, CFCs will be banned from production starting January 1, 1996, because of their adverse effects on ozone in the upper portions of the atmosphere. Although LES does not intend to use CFCs, firm substitutes have not yet been identified. LES indicated that at the present time, HFC-134a appears to be one of the more promising substitutes for Freon R-11 (LES, 1994a). This potential substitute contains no chlorine and has been recommended by EPA as an appropriate replacement for Freon R-11. Axarel® 6000 and 9000 series cleaning agents have been identified to replace Freon

R-113 as a degreaser (LES, 1994b). Axarel® is a product that contains aliphatic hydrocarbons that are not ozone-depleting substances. Since there are no direct connections between the CFC systems and systems containing UF_6, no changes in radiological effluent of the CEC are expected to occur (LES, 1994b).

2.3.4 Waste Management System

Operation of the CEC will result in the production of gaseous, liquid, and solid waste streams. Each stream could contain hazardous and radioactive compounds either alone or in combination. This section presents brief descriptions of the sources and quantities of the waste streams and of the systems used to treat these streams prior to release to the environment.

2.3.4.1 Gaseous Waste Management

Gaseous streams that would be released to the environment during normal operation of the CEC include exhausts from the general purpose HVAC systems serving each of the buildings and the exhaust from the process off-gas or the GEVS serving equipment in the Separations Building. Of these systems, only the Separations Building TSA and the GEVS would be expected to release radioactive compounds to the environment. The GEVS uses five parallel air pre-filters, five HEPA filters, and five activated carbon filters (impregnated with potassium carbonate) for final effluent cleanup. Normal ventilation air and potentially contaminated gaseous effluents will be released to the atmosphere at an elevation of 36.6 meters (120 feet) through the main stack (Plant Unit 1) north of the Separations Building. The GEVS will be sampled for radioactivity, online monitoring will be performed for HF, and the GEVS would be shut down when the alarm sounds. CEC is also subject to the National Emission Standards for Hazardous Air Pollutants (NESHAPS) requirements identified in 40 CFR Part 61, Subpart I. Minor amounts of chemically hazardous compounds, including acetone and freon compounds, would be released to the environment from HVAC systems serving the Separations Building and the CAB. According to the Federal Clean Air Act (CAA), CEC emissions will not be classified as a major source generator as defined in the Prevention of Significant Deterioration (PSD) regulations. CEC, however, is required to apply for an air quality permit from the LDEQ, according to the State Environmental Quality Codes and to EPA under 10 CFR Part 61.

The TSA HVAC system services the Decontamination Workshop, the Contaminated Workroom, and the laboratory equipment that might produce small quantities of airborne uranium. The HVAC system servicing these areas will use a once-through design with HEPA filtration as well as standard particulate filters and activated carbon filters to control releases to the environment. Gaseous radioactive material released from separations equipment, such as autoclaves and desublimers, would be collected in the GEVS. The GEVS will include a pre-filter, a HEPA filter, and a carbon bed absorber for removal of uranium and fluorine compounds prior to release to the atmosphere through one of the three exhaust stacks. The HVAC systems serving clean areas of the Separations Building

and all areas of the CAB and the Cylinder Receipt and Dispatch Building will release ventilation air to the atmosphere without filtration of the effluent stream.

^{238}U and ^{234}U will constitute the critical radionuclides for gaseous pathways. Average source term releases to the atmosphere are conservatively estimated to be 4.4 MBq (120 μCi) per year (LES, 1994a). Urenco experience in Europe, on the other hand, indicates that uranium discharges from gaseous effluent vent systems are less than 10 grams per year or 1 MBq (28 μCi) for facilities with similar designs and throughput. Therefore, 4.4 mBq is a very conservative estimate and will be used in all calculations. By using the higher source term, NRC has estimated the atmospheric uranium concentration to be approximately $4.8x10^{-8}$ Bq/m^3 ($1.3x10^{-18}$ μCi/ml) and $6x10^{-8}$ Bq/m^3 ($1.6x10^{-18}$ μCi/ml) for the maximum onsite and offsite receptors, respectively. These estimated concentrations are very small fractions of the 10 CFR Part 20 regulatory limit for release to restricted and unrestricted areas. The 10 CFR Part 20 regulatory limit for soluble uranium in air is $1.11x10^{-1}$ Bq/m^3 ($3x10^{-12}$ μCi/ml).

Estimates of the potentially hazardous materials released to the atmosphere are presented in Table 2.9. The radiological components and the bulk of the trichlorotrifluoroethane (Freon R-113) would be released from the Separations Building while the methanol and acetone would be released from the CAB. In addition to these major release points, minor quantities of fugitive vapors would be released from the backup power systems. Since CFC production will be banned in the U.S. starting January 1, 1996, LES has identified Axarel® 6000 or 9000 series cleaning agents as potential substitutes for Freon R-113 (LES, 1994b). These compounds are made up of aliphatic hydrocarbons or esters with low vapor pressures that would minimize the emissions of volatile organic carbons to the air. Although these compounds are not considered hazardous in terms of the Resource Conservation and Recovery Act (RCRA), they are listed in the Toxic Substance Control Act.

2.3.4.2 Liquid Waste Management

Liquid waste streams released from the CEC will include stormwater runoff, treated sanitary and industrial wastewater, and treated radiologically contaminated wastewater. Estimates of the annual quantities of released materials in liquid effluent streams are presented in Table 2.10.

A process flow diagram of liquid effluents is provided in Figure 2.12. The destination of the liquid waste stream releases is Bluegill Pond. The point of release is represented as Outfall 001 in the National Pollutant Discharge Elimination System (NPDES) application (LES, 1992e). The LDEQ, however, has indicated that it plans to ask LES to relocate Outfall 001 and discharge below Bluegill Pond (LDEQ, 1994). The Yard Drain System will collect stormwater from the yard and building roofs via drains and will be routed through a Hold-Up Basin and released to Bluegill Pond at Outfall 002 without treatment. This outfall is also addressed in the NPDES application. The rate of discharge from the system will be controlled to minimize erosion around Bluegill Pond and in Cypress Creek. During

Table 2.9 Estimated Annual Atmospheric Emissions from the CEC (LES, 1994a)

Emissions Component	Estimated Annual Quantity Released
Ventilation System Discharge	13×10^8 m^3 (4.6×10^{10} scf)
Trichlorotrifluoroethane (Freon R-113)	8,640 kg (19,000 lbs)[a]
Methanol	15 kg (33 lbs)
Perchlorethylene	10 kg (22 lbs)
Acetone	123 kg (270 lbs)
Nitrogen	378,541 liters (100,000 gallons)
Hydrogen Fluoride	<6.4 kg (14 lbs)
Uranium (in compounds)	<10g[b]
Laboratory Materials (water, acid)	946 liters (250 gallons)
Combustion Products	Trace
Thermal Waste	1.37×10^9 J/hr (7.8×10^7 BTU/hr)

[a] A substitute for Freon R-113 will be used but has not yet been identified
[b] 120 μCi of uranium was used in the NRC atmospheric analysis

Table 2.10 Estimated Liquid Discharges from the Sewage Treatment System at the CEC (LES, 1994a)

Liquid Waste Constituent	Estimated Annual Quantity Discharged*
Biocide	3.6 kg (0.4 mg/l)
Corrosion Inhibitor	3.6 kg (0.4 mg/l)
Chlorine	9.5 kg (≤1 mg/l)
Fluorine	18 kg (≤2 mg/l)
Detergent	Trace
Toxic Lab Chemicals and Miscellaneous Solvents	9.1 kg (<1 mg/l)
Uranium	9.5 g (<0.001 mg/l)

Estimated annual flow is 9,500,000 liters.

the construction phase of the CEC, the Hold-Up Basin will be used as a sedimentation control device. A water level of approximately 6 m (22 ft) will be maintained in the Hold Up Basin, except during periods of light rainfall, when the level will likely be lower. Thus, LES may be classifiedhe discharge rate will be controlled by the discharge standpipe. An emergency spillway will be provided to prevent breaching of the dam during unusual storms (LES, 1993a). During the operational phase of the CEC, no water accumulation would be expected in the Hold Up Basin during periods of little or no rainfall. The sanitary and industrial wastewater streams would be processed in the Sewage Treatment System, while

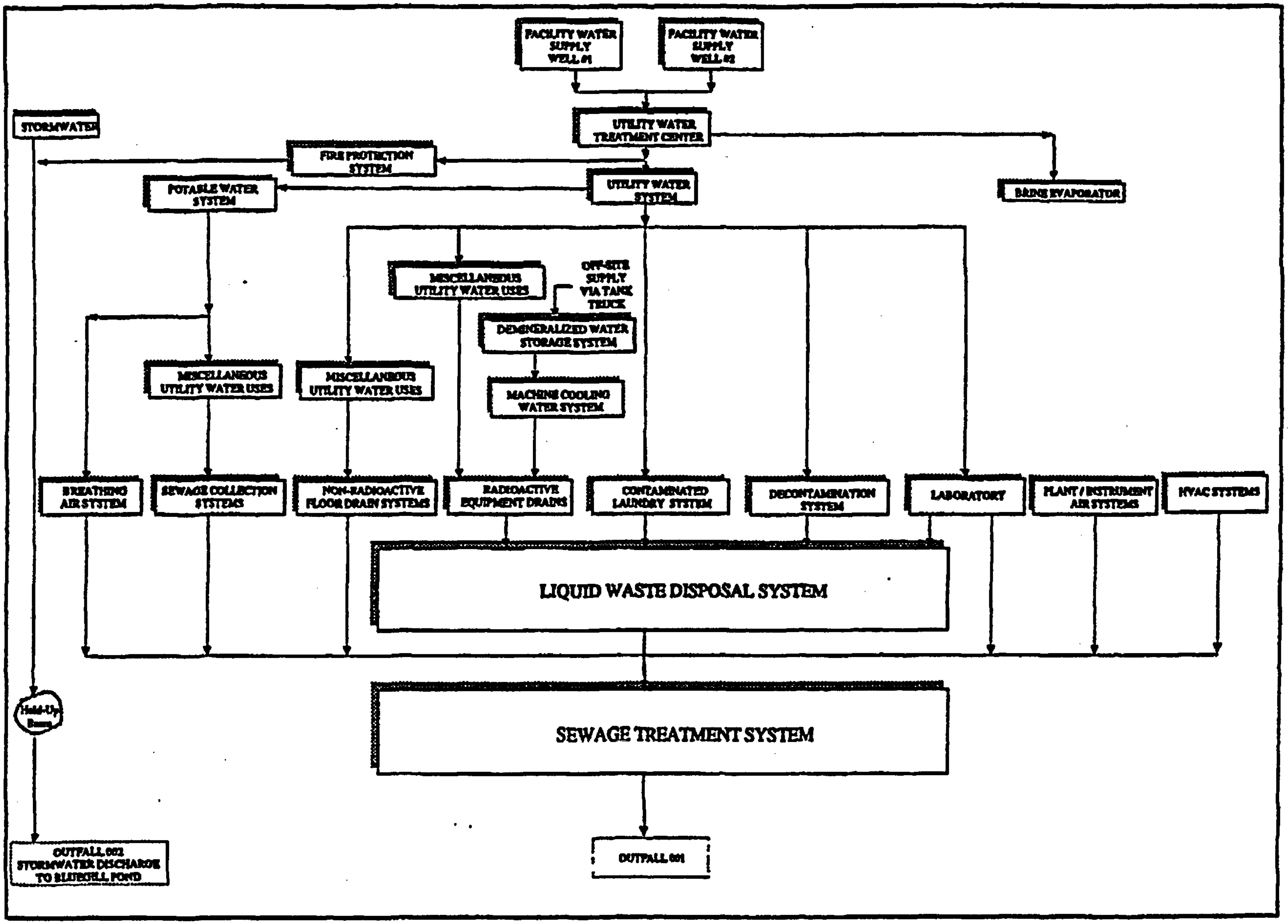


Figure 2.12 Process Liquid Effluent Flow Diagram

the radiologically contaminated streams would be processed in the Liquid Waste Disposal System (LWD) and then in the Sewage Treatment System. Under normal operation, it is estimated that 9,500 m^3 of treated liquid effluents will be discharged annually to Bluegill Pond (LES, 1993a). In addition, approximately 378,000 m^3/yr of stormwater would be released to Bluegill Pond via the CEC Hold-Up Basin.

The radiologically contaminated liquid streams generated in the Separations Building will be comprised primarily of spent decontamination solutions, liquids from floor drains, liquids from laundry drains, and evaporator flush water. Uranium is the only radioactive material that is expected to be found in these wastes. Estimates of the quantities and radiological contamination levels of these waste streams are presented in Table 2.11. Radioactive elements would be removed from the wastewater in the LWD using a combination of precipitation, evaporation, and ion exchange. All effluents that are potentially contaminated with uranium will be collected in collection tanks located in pits to contain and recollect any spills or overflow. All effluent collection tanks will be isolated, mixed, and sampled for uranium content prior to transfer to the dryer feed tank. The contents of the spent citric acid tank and some laboratory solutions will be pretreated prior to transfer to the dryer feed tank. The pretreatment will consist of raising the pH, by adding potassium hydroxide, to precipitate the uranium compounds. The precipitate will be collected by recirculating the solution through the LWD centrifuge.

The precipitate will be collected and transferred to the Solid Waste Disposal System (SWD), and the liquids will be transferred to the collection tanks. Liquid waste will be pumped through the dryer feed filter to the dryer feed tank in batch form. The dryer feed tank will have a capacity of 19 m^3 (5,000 gallons). Feed to the dryer will be via a recirculation loop. The dryer will be a wiped thin-film evaporator that separates the liquid into a water vapor stream and a solids stream in one step. Solids will then be collected in drums for disposal. Typical disposal packaging will be a carbon steel drum inside a High Integrity Container. Distillate will be collected, mixed, and sampled for uranium. If the uranium content of the condensate is greater than 5 percent of the 10 CFR Part 20 limit for release to unrestricted areas, the batch will be retained for further processing which may include demineralization. The treated water will be transferred to the Sewage Treatment System and the concentrated radioactive solids will be removed and then disposed of as low-level radioactive waste.

Liquids from the nonradiologically contaminated floor, HVAC systems, and sewage drains from the CEC buildings will be combined with the LWD System effluent and transferred to the Sewage Treatment System. The Sewage Treatment System is designed to handle between 23 and 32 m^3 daily and it will use a combination of aeration, settling, filtration, and chlorination to produce a purified water stream and a sludge waste stream. Treated water from the Sewage Treatment System would be released to Bluegill Pond and the sludge disposed of as sanitary waste. The discharge of nonradiological pollutants will occur in accordance with the administrative limits of CEC operation and the limits established in the CEC's NPDES permit. The characteristics of daily discharges of pollutants are listed in Table 2.12. Nonradiological substances that may be discharged in the liquid effluent include

Table 2.11 Characteristics of Radiologically Contaminated Liquid Waste Prior to Treatment (LES, 1994a)

Source	Volume (l/yr)	Uranium Content (kg/yr)	Uranium Concentration (mg/l)	Resulting Quantity of Waste
Laundry Drains	681,300	0.11	0.15	Dryer concentrate: 1,820 kg Uranium: 1 kg
Floor Drains	174,100	0.01	0.05	
LWD Dryer Flush Water	94,600	0.02	0.24	
Laboratory Drains	70,000	0.01	0.13	
Decontamination Rinse Water	12,500	0.86	70.0	
Spent Decontamination and Laboratory Solutions	10,200	36.3	3600.0[a]	Precipitate: 227 kg Uranium: 36 kg

[a]Pretreated to remove uranium prior to processing in the dryer.

the various laboratory chemicals listed in Table 2.13 and oil and grease. The administrative limit of uranium in the liquid waste streams released to Bluegill Pond is 0.55 Bq/l (1.5×10^{-9} µCi/ml) which is 0.5 percent of the 10 CFR Part 20 limit.

Radiologically and nonradiologically contaminated nonaqueous liquids will be produced in small quantities by CEC operation. These liquids will include lubrication oils, solvents, laboratory chemicals, and miscellaneous liquid materials. The miscellaneous liquid materials will include heavy oils and heat transfer fluids, ethylene glycol, and freon. The expected annual volume of radiologically contaminated, nonhazardous liquid is 100 liters of hydrocarbon oil. Annual volumes of liquid mixed waste are estimated to include 25 liters of acetone and 600 liters of laboratory chemicals. Both classes of these liquids will be contaminated at trace levels with uranium. Estimated annual volumes of nonradiologically contaminated liquids include 3,400 liters of oils, 80 liters of Freon R-113 (substitute not yet determined but equivalent volume expected), 15 liters of methanol, and 10 liters of perchloroethylene. Nonaqueous liquid wastes will be collected at the point of generation and transferred to the waste storage area section of the TSA. Properly packaged and labeled shipments of these materials will be transported offsite for treatment or disposal at authorized facilities.

Table 2.12 Expected Pollutant Concentrations in Daily Discharges to Surface Water (LES, 1992e)

Parameter	Maximum Daily Concentration	Average Daily Concentration
pH	6.5	7.0-7.5
BOD	30 mg/l	10 mg/l
COD	70 mg/l	35 mg/l
TOC	15 mg/l	10 mg/l
TSS	5 mg/l	2 mg/l
Ammonia	5 mg/l	3 mg/l
Carbon Tetrachloride	0.001 µg/l	ND
Total Residual Chlorine	0.9 mg/l	0.6 mg/l
Fecal Coliform	15 colonies/100 ml	7 colonies/100 ml
Fluoride	<5 mg/l	<2 mg/l
Sulfate	15 mg/l	10 mg/l
Oil/Grease	0.05 mg/l	0.01 mg/l
Aluminum	<0.1 mg/l	≤0.1 mg/l
Lead	<1.5 µg/l	≤0.3 µg/l
Mercury	<0.003 µg/l	≤0.001 µg/l

ND = Not detectable.

2.3.4.3 Solid Waste Management

Solid waste generated at the CEC will be grouped into industrial (nonhazardous), radioactive, hazardous, and mixed waste categories. In addition, solid waste will be further segregated according to the quantity of liquid that is not readily separable from the solid material. The solid waste management system will be a set of facilities, administrative procedures, and practices that provide for collection, temporary storage, processing, and disposal of categorized solid waste in accordance with regulatory requirements. All solid radioactive wastes generated will be Class A low-level wastes (LLW) as defined in 10 CFR Part 61. LES expects to use the Central Interstate Compact facility in Nebraska for disposal of LLW (LES, 1994b). Although the facility is not currently operational, it should be available by the time LES would need to dispose of radioactive waste. If the site is not yet available, LES might need to temporarily store the waste at the CEC until the site is available.

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Industrial waste, including miscellaneous trash, filters and filter material, resins, and paper will be shipped offsite for compaction and then sent to a licensed waste landfill. CEC is expected to produce approximately 20,000 kg of normal trash annually (LES, 1994b).

Radioactive waste, which will be comprised of contaminated filters, oily sludges, resins, equipment, wipes, and miscellaneous contaminated trash will be collected in labeled containers in each Radiation Control Area and transferred to the Radioactive Waste Storage Area for inspection. Suitable waste will be volume-reduced and all radioactive waste disposed of at a licensed LLW disposal facility. Lubrication oils, solvents, sludges, laboratory waste, and miscellaneous wastes containing hazardous material, either alone or in combination with low levels of uranium contamination, will be generated at the CEC. These wastes will be collected at the point of generation, transferred to the Waste Storage Area, inspected, and classified. The oily sludge generated from recovery of used Fomblin Oil may be reduced in volume or may be solidified in drums using Portland cement along with a binder and then shipped out for disposal to a licensed LLW disposal facility.

Estimated quantities of industrial solid waste that would be disposed of at a commercial landfill are presented in Table 2.14. Estimates of the quantities of hazardous waste are presented in Table 2.15, and estimates of the quantities of low-level radioactive and mixed wastes are presented in Table 2.16. The hazardous waste generated by the CEC will be transferred to a hazardous waste disposal firm. LES has not selected a specific company, but there are currently firms that serve Claiborne Parish and they should be able to

Table 2.14 Projected Quantities of Nonradioactive Solid Waste Generated at CEC During Operation (LES, 1994a)

Waste	Estimated Annual Quantity
Resins	0.60 m^3 (21 ft^3)
Silica gel	0.03 m^3 (<1 ft^3)
Activated alumina	272 kg (600 lbs)
Oils	3,407 liters (900 gallons)
Oil filters	45 kg (100 lbs)
Air filters	2,945 kg (6,500 lbs)
Activated carbon	23 kg (50 lbs)
Salt	2,356 kg (5,200 lbs)
Scrap metal	1,993 kg (4,400 lbs)
Trash	19,479 kg (43,000 lbs)
Miscellaneous wet solids	55 kg (120 lbs)
Sewage sludge	5,896 kg (13,000 lbs)

Table 2.15 Projected Quantities of Hazardous Waste Generated at CEC During Operation (LES, 1994a)

Waste	Estimated Annual Quantity
Hazardous trash	454 kg (1,000 lbs)
Solvent sludge	68 kg (150 lbs)
Solvent (Freon R-113)	76 liters (20 gallons)
Lab and other waste	91 kg (200 lbs)
Methanol	15 kg (33 lbs)
Perchlorethylene	10 kg (22 lbs)

accommodate the CEC hazardous waste. As for mixed waste, a firm in Tennessee has indicated that it could accommodate the types of mixed waste that would be generated at the CEC (LES, 1994b). Transportation of all wastes will be in accordance with 49 CFR 107 through 49 CFR 400.

LES estimates that the CEC will generate 1,110 kg of RCRA hazardous wastes per year (about 650 kg/yr of hazardous and 460 kg/yr of mixed waste). This is an average of

Table 2.16 Estimates of Low-Level Radioactive and Mixed Waste Generated at CEC Annually During Operation (LES, 1994a)

	Radiological Waste		Mixed Waste	
Waste Type	Quantity (kg)	Uranium (kg)	Quantity (kg)	Uranium (kg)
Activated Carbon	680	55	45	0.5
Activated Alumina	160	1.8	-	-
Ventilation Filters	840	0.5	-	-
Demineralizers Resin	136	0.01	-	-
Waste Precipitate	200	36	-	-
Dryer Concentrate	1,820	1.0	-	-
Solvent Recovery Sludge	-	-	115	5
Laboratory Wastes[a]	115	1.8	70	1.8
Trash	7,270	10	230	0.5
Scrap Metal	130	trace	-	-
Fomblin Oil Recovery Sludge	25	0.5	-	-

[a] Dry wastes are in kg. Mixed waste includes 60 percent water, common nonhazardous laboratory chemicals, uranium, and small amounts of hazardous chemicals. Hazardous chemicals include isopropylether (60 kg), carbon tetrachloride (9 kg), carbon disulfide (2 kg), chromium compounds (0.5 kg), acetone (0.5 kg), and traces of n-hexane and 1,1,2 trifluoro-1,2,2 trichloroethane.

92.5 kg/month. Under Federal regulations, a facility that generates less than 100 kg/month is conditionally exempt. The State of Louisiana, on the other hand, has a stricter regulation and facilities that generate less than 100 kg/month are classified as small quantity generators. Thus, LES may be classified as a small quantity generator. In general, generators are allowed to store hazardous wastes for 90 days without a permit (Louisiana Administrative Code Title 33:v 105 (D)(2)). Small quantity generators are allowed to store wastes for 180 days, provided the total amount never exceeds 1,000 kg/yr. If a small quantity generator has to ship wastes farther than 200 miles, the waste can be stored for up to 270 days. LES plans to ship hazardous and mixed waste offsite within the allowed timeframe, therefore, no permit should be necessary.

2.3.4.4 Pollution Prevention and Waste Minimization

The Pollution Prevention Act of 1990 reinforces the U.S. EPA's environmental management priorities. The highest priority has been assigned to preventing pollution through reduction and reuse or recycling.

CEC incorporates several waste minimization systems in its operational procedures that aim at conserving materials and recycling important compounds. All Fomblin Oil will be recovered and none will be routinely released as waste or effluent. Fomblin Oil is an expensive, highly fluorinated, inert oil selected specially for use in UF_6 systems to avoid reactions with UF_6. Also, the CEC Refrigerant Supply System will incorporate a high efficiency two-stage vapor recovery unit to minimize the discharge of refrigerant to the environment. The degreasing unit will be equipped with a vapor recovery unit and distillation still to minimize release of degreasers. LES will also have a Decontamination System designed to remove radioactive contamination from equipment and materials, which allows some equipment and material to be reused rather than treated as waste.

In addition, the CEC process systems which handle UF_6 will operate entirely at subatmospheric pressure which will prevent outward leakage of UF_6. UF_6 cylinders will be transported only after being cooled and the UF_6 is in solid form to minimize potential risk of accidental releases due to mishandling.

CEC is designed to minimize the usage of natural and depletable resources. Closed-loop cooling systems have been incorporated in the designs to reduce water usage. Power usage will be minimized by efficient design of lighting systems, selection of high-efficiency motors, and use of proper insulation materials.

2.3.4.5 Disposition of Tails

The depleted UF_6 (DUF_6) exiting the separation cascades will contain approximately 0.2 weight percent ^{235}U and could be a potential resource. However, because there is already a large supply of this material and a limited market, the tails may eventually require long-term disposal. The CEC's possession limit for the tails will be 80,000 metric tons (88,200 tons) of DUF_6 or the amount of DUF_6 produced during 15 years of CEC operation, whichever is less. Thus, no later than 15 years after commencement of CEC operations, the transportation of DUF_6 offsite for disposal will commence. Due to the reactivity of DUF_6 with water, the tails will be converted to a more chemically stable form before disposal at an offsite facility (LES, 1992b). From the standpoint of potential long-term stability in a geologic environment, the DUF_6 will most likely be converted to U_3O_8. This section provides a summary of the conversion process from DUF_6 to U_3O_8, representative of expected conditions. The potential impacts of the conversion process and disposal of U_3O_8 are summarized in Section 4.2.2.7, and detailed assumptions and analyses for both steps are presented in Appendix A.

Conversion of DUF_6 to U_3O_8 can be accomplished in a two-step chemical reaction process. In the first step, DUF_6 is reacted with steam at elevated temperatures and converted to Uranyl Fluoride, UO_2F_2 and HF. In the second step, the UO_2F_2 byproduct is reacted with hydrogen (H_2) and oxygen (O_2) at elevated temperatures to produce U_3O_8. The DUF_6 generated at the CEC will be transported to the conversion plant in Type 48G cylinders, each containing up to 12.7 metric tons (14 tons) of DUF_6.

The DUF_6 will be vaporized in an autoclave and then fed to a hydrolysis reactor. The UO_2F_2 will be separated from the steam and the HF byproduct in porous metal filters and then fed to a conversion reactor. The solid U_3O_8 generated in the conversion reactor will be separated from the effluent gas in porous metal filters and will then be loaded into drums for transfer to a disposal facility. Assuming a 20-year operational period for the conversion plant, the DUF_6 feed rate would be approximately 5,700 metric tons/yr (6,285 tons/yr), which would be equivalent to a U_3O_8 production rate of 4,545 metric tons/yr (5,000 tons/yr).

The gases exiting both the hydrolysis reactor and the conversion reactor will contain HF which then must be managed either as a byproduct or as waste. To be conservative, the HF is assumed to be managed as waste. In this case, a scrubber system comprising spray towers and packed towers in series could be used to recover HF. The HF absorbed into the alkaline scrubber solution would contain very small quantities of uranium and would be precipitated as calcium fluoride (CaF_2) in a series of mixer-settler tanks. On a dry basis, the maximum uranium content of the CaF_2 precipitate is estimated to be 0.05 Bq/g (1.4 pCi/g). It is estimated that approximately $3.4x10^{+7}$ liters/yr ($9.0x10^{+6}$ gallons/yr) of liquid from the scrubber system will be released to the environment. To be conservative, it is assumed that all of the uranium entering the scrubber system will be released in the liquid effluent. Thus, the liquid release source term would be approximately $1.9x10^{+8}$ Bq/yr ($5.2x10^{-3}$ Ci/yr). The primary sources of release to the atmosphere will be the scrubber off-gas and dust from the product load-out system. Approximately $3.8x10^{+5}$ Bq/yr ($1.0x10^{-5}$ Ci/yr) and $2.9x10^{+7}$ Bq/yr ($7.8x10^{-4}$ Ci/yr) are estimated to be released to the atmosphere in the scrubber off-gas and the dust from the load-out system, respectively.

2.3.5 Decontamination and Decommissioning

The CEC site and facilities will be decontaminated and decommissioned at the end of CEC's useful life of operation. The building shells and site will be decontaminated to the level where they can be released for unrestricted use. All radioactive waste will be removed for offsite disposal in licensed, LLW burial grounds. All hazardous waste will be treated or disposed of in authorized offsite facilities. Following decommissioning, all of the CEC facilities and site are expected to be released for unrestricted use (LES, 1994a and 1993a).

The CEC is designed to minimize the generation and storage of radioactive and hazardous wastes and to minimize the contamination of equipment and structures. The decommissioning plans will be implemented using proper management and health and safety programs (LES, 1994a). In addition, LES will conduct its operations to minimize the generation of waste, minimize contamination of the CEC, dispose of wastes as they are generated, keep records of spills or other unusual occurrences involving the spread of contamination, and maintain as-built drawings of all buildings. This will facilitate the eventual D&D of the CEC.

LES (1994a) has identified decommissioning activities and estimated the required decommissioning cost (Table 2.17). Current plans call for the removal of all of the process equipment (e.g., centrifuges and process piping) and the equipment that provided direct support to the enrichment equipment (e.g., refrigerant and chilled water systems). Plans also call for the construction of two decontamination structures that will be housed within the existing facilities to avoid unnecessary expense. Estimated time for installation of these new structures is approximately 1 year following shutdown of the CEC. The first structure will be for the decontamination of centrifuges and the second will be for the decontamination of larger, non-routine pieces of equipment. Equipment that is decontaminated to below NRC limits may be reused or sold as scrap. All salvaged scrap that contains a significant amount of aluminum along with smaller amounts of steel, copper, and other metals may be sold. Based on Urenco decommissioning experience in Europe, approximately 88 percent of the aluminum delivered to the smelter was suitable for resale, while the remaining slag was disposed of as nonradioactive waste. However, the salvaged scrap must meet the NRC release criteria that will be in place at the time of decommissioning.

Any tails remaining at the site will be removed during the decommissioning phase. Any contaminated portions of the CEC will be decontaminated to levels required by NRC regulations at the time of decontamination. In general, D&D is divided into several steps. These steps are:

(1) System Cleaning. This involves the removal of UF_6 to the fullest extent possible, evacuation of the enrichment system, and purging with nitrogen.

(2) Dismantling. This involves cutting, disconnecting, and disassembling all components of the Enrichment System. This is a laborious, intensive process and requires several precautions to ensure that cutting and removal operations are balanced with the resultant decontamination and disposal requirements.

(3) Decontamination. This is the cleanup step. Procedures for decontamination will be developed to minimize worker exposure and waste volumes. LES will incorporate the decommissioning experience gained in Europe in this step (LES, 1994a). All recoverable items will be decontaminated and made suitable for reuse, consistent with NRC limits. The primary material requiring disposal may include the centrifuge rotor fragments, trash, and residue from the effluent treatment systems. The surrounding soils and sediments are not expected to require decontamination; but their status, as well as the status of the facility, will be determined by a final radiation survey prior to license termination.

Wastes will primarily consist of normal industrial trash, nonhazardous chemicals and fluids, small amounts of hazardous materials, and radioactive wastes. The radioactive wastes will contain largely crushed centrifuge rotors, trash, and citric cake (uranium and metallic compounds precipitated from citric acid decontamination solutions). LES (1994a) has also

Table 2.17 Estimated Costs and Duration of Decontamination and Decommissioning (D&D) Activities[*] (LES, 1994a)

D&D Activity	Cost ($ Millions, in 1996 Dollars)	Time (Years)
Characterize CEC facility and site	0.22	0.50
NRC staff review of facility/site characterization	0.05	0.33
Develop detailed decommissioning plan and submit to NRC	0.22	0.50, (a)
NRC staff review and approval of decommissioning plan	0.05	0.33
Idle time between cessation of operations and start of decommissioning activities	1.00	0.50
Decontamination Facility Installation, System Cleaning, Dismantling, Decontamination	23.10	4.00
D&D of Decontamination Facility	1.90	(b)
Sale/Salvage of Decontaminated Equipment	0.00	(b)
Radioactive Waste Disposal	1.40	(b)
Hazardous/Mixed Waste Disposal	0.10	(b)
Tails Disposition	485.30, (c)	(b)
LES Final Radiation Survey and NRC Confirmatory Survey	1.50	1.25
Contingency	3.50	N/A
TOTAL	518.34	7.1

[*] *For related information, refer to the decommissioning funding plan contained in the CEC License Application (LES, 1994c).*

(a) Includes 4-month overlap with NRC review of the characterization phase.
(b) To be performed along with dismantling and decontamination.
(c) Tails disposal costs are estimated to be $16.175 million per year of tails production.

made a preliminary estimate of the volume of radioactive waste that will be produced during the D&D phase. LES estimates that D&D would generate approximately 100 m^3 of radioactive waste (LES, 1994a) during an anticipated 7-year period. This estimate is based in part on the equipment decontamination experience of Urenco at its European plants. Radioactive waste will ultimately be disposed of at licensed low-level radioactive waste disposal facilities. Hazardous waste will be disposed of at licensed hazardous waste disposal

facilities. Nonhazardous and nonradioactive waste will be disposed of in a manner consistent with good disposal practices.

As shown in Table 2.17, LES has estimated that the total cost of D&D, based on 1996 dollars, is approximately $518 million, with most of these funds (94 percent) being required for the disposal of the tails. Costs are based on converting UF_6 to U_3O_8 with subsequent disposal in a licensed facility. Funds to cover tails disposition will be set aside during the operating life of CEC and will include an estimated $16.2 million per equivalent year of tails production. LES will be required to review and revise the CEC decommissioning funds, including DUF_6 disposition, at least every 5 years and adjust the decommissioning funding mechanism appropriately (LES, 1994c).

2.4 Conclusions and Recommendations

Based on the evaluation in this EIS, the staff has concluded that licensing LES for construction and operation of an enrichment facility in Claiborne Parish, Louisiana will not result in a significant impact to the environment. The staff has not identified any mitigating measures beyond those proposed that should be implemented. However, the staff does recommend changes to the environmental monitoring program. The following recommendations will serve to enhance the monitoring program:

1. LES shall establish an action level of 1.85×10^{-4} Bq/g (0.005 pCi/g) for gross alpha (uranium) in vegetation. Section 5.3.1.

2. LES shall sample the receiving water streambed sediment for gross alpha (uranium) as part of the sediment monitoring. Section 5.3.1.

3.0 THE AFFECTED ENVIRONMENT

3.1 General Site Description

The area of Claiborne Parish, Louisiana is located in the Pine Hills subprovince of the north central portion of the Gulf Coastal Plain physiographic province. It is situated 80 km (50 miles) northeast of Shreveport in the gently sloping, tree-covered hills of northern Louisiana, near the Kisatchie National Forest lands (Figure 3.1). The proposed site has an area of 179 hectares (442 acres); approximately 28 hectares (70 acres) will be developed for the Claiborne Enrichment Center (CEC). The remaining area will remain in a natural state with no projected industrial use. Parish Road 39, a paved road crossing from north to south near the middle of the site, provides easy access. In addition, State Route LA 2 runs eastward from Homer to Lisbon and Bernice, crossing LA 9 at the western outskirts of Homer. Both LA 9 and LA 2 provide access to U.S. Highway 79, which is a connector to Interstate 20 West by way of Minden. LA 9 provides a connection to Interstate 20 East, which is directly south of the site. Interstate 20 runs east to west approximately 30 km (20 miles) to the south of the proposed site. This provides a good transportation route for trucks. Also, the Homer Municipal Airport is only about 8 km (5 miles) from the proposed site. The Center Springs community is located approximately 0.5 km north of the site and the Forest Grove community is located approximately 3.2 km (2 miles) to the south.

The proposed site is mainly a wooded lot with gently rolling hills. It is approximately square in shape with a flat central area. The area to the west of Parish Road 39 has recently been cleared of most vegetation, leaving stumps approximately 15 cm (6 inches) high. The vegetation over the remainder of the site is thick, consisting mainly of pine forests with some scattered oak trees and underbrush.

The Mississippi River runs to the east, and the Red River is located to the west of the area surrounding the site. These rivers and their feeder streams flow south to the Gulf of Mexico in broad, steep-sided, flat valleys. The mean elevation of this area is approximately 30 to 45 m (100 to 150 ft) above mean sea level (MSL). The proposed CEC site is located on a small drainage divide at approximately 85 to 100 m (280 to 320 ft) MSL in the western portion of the Ouachita River Basin. Major surface water bodies on the site consist of small intermittent streams and two manmade lakes: Bluegill Pond and Lake Avalyn (Figure 3.2). Local drainage from the site flows west and east into several small streams and creeks that eventually flow into Lake Claiborne to the south or Bayou D'Arbonne to the east.

3.2 Geology, Soils, and Seismology

3.2.1 Geology

This section presents the general geology of the proposed CEC site and vicinity, including a summary of the geologic history of the area and a description of the soils found at the site.

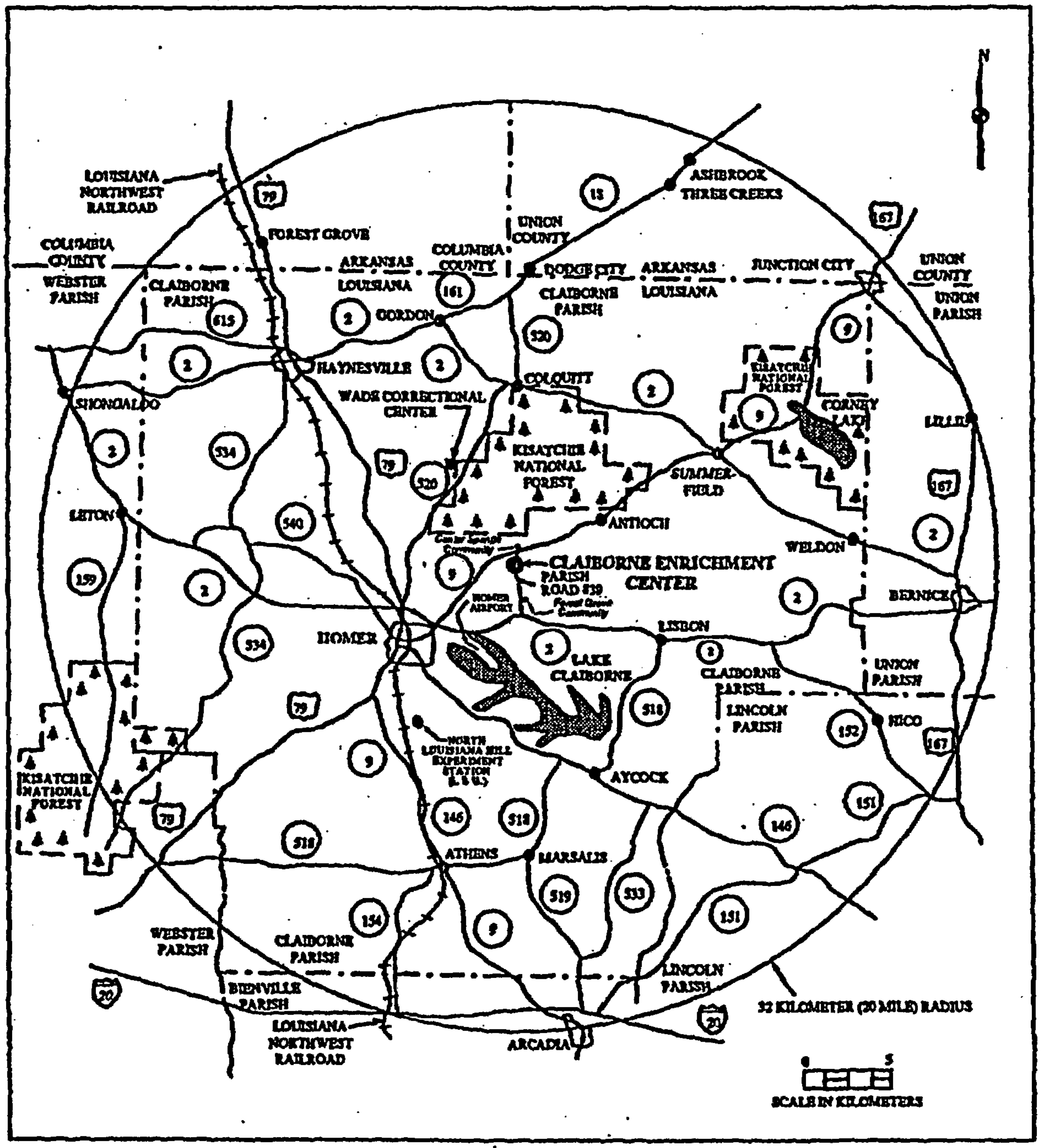

Figure 3.1 Regional Map of the Proposed CEC Site and Surrounding Area

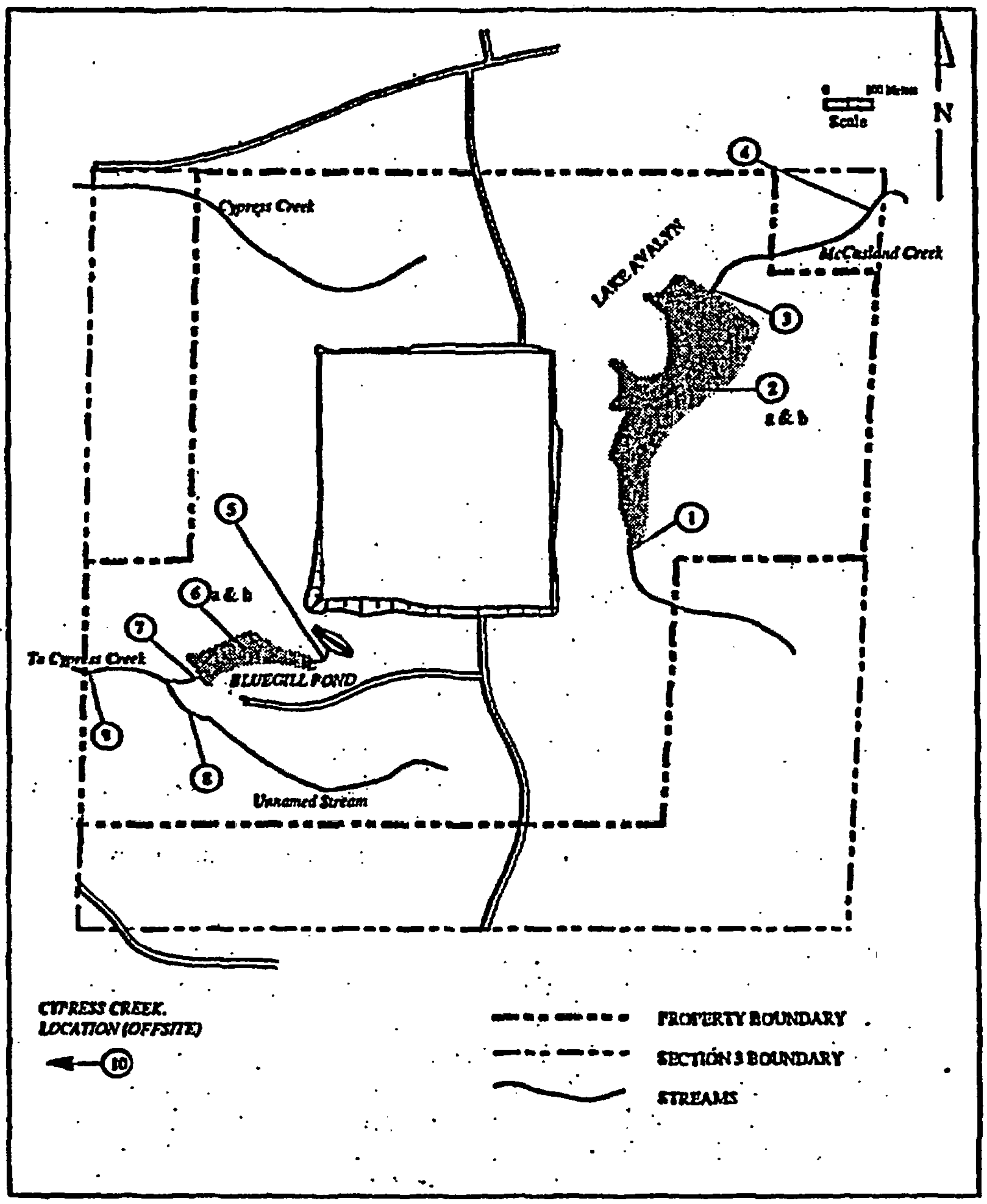

Figure 3.2 Major Surface Water Bodies at the Proposed CEC Site and Sampling Locations

A discussion of the seismicity of the area is also presented, including an assessment of historical seismicity and potential hazards resulting from future seismic activity.

3.2.1.1 Regional Geology

The geology of northern Louisiana reflects the deposition of sedimentary rocks throughout the Mesozoic and Cenozoic eras. Figure 3.3 shows the generalized bedrock geology of Louisiana, and Table 3.1 provides a composite stratigraphic section of Louisiana. Strata were generally deposited in deltaic and near-shore environments and consist of intermittent and discontinuous lenses of marine and nonmarine sands, silty sands, and clays. The development of this stratigraphic sequence began with carbonate deposits in the Late Jurassic System and continued with deltaic clastic deposits, carbonate reefs, salt basins, and lagoonal sediments in the early Cretaceous System. The remainder of the Cretaceous System was marked by deposition of clastics and extensive chalk and marl sequences. A sequence of deltaic sands and shales was deposited in the Tertiary System. As a result of sea level fluctuations, Pleistocene and more recent deposits generally lie unconformably on the Tertiary sediments.

Geologic strata found in the vicinity of the CEC site are, from youngest to oldest, Pleistocene terrace and alluvial deposits and members of the Eocene Claiborne Group, including the Cockfield Formation, the Cook Mountain Formation, the Sparta Sand, and the Cane River Formation (Figure 3.4). The Claiborne Group lies conformably on the Carrizo Sand. The Carrizo Sand overlies the Paleocene Wilcox Group which lies on the early Paleocene Midway Group. Beneath these strata exists an additional 5,500 m (18,000 ft) of sedimentary rock deposited since the formation of the Triassic basement rocks.

The CEC site lies on the middle Tertiary Cockfield Formation, which is covered in some areas of Claiborne Parish with Pleistocene marine terrace and recent alluvial deposits. At the site, however, Pleistocene terrace deposits are not found; they are presumed to have been eroded and incorporated into alluvial sediments (Law Engineering, 1990a; LES, 1993a).

The Cockfield Formation consists of an upper nonmarine and a lower marine unit that are primarily composed of fine-grained sands with some silts and clays. Layers of siderite present in the lower marine unit create local perched water tables that are manifested as seeps and springs in exposed hillsides (Law Engineering, 1990b). The Cockfield Formation lies conformably on the Cook Mountain Formation, which consists predominantly of silty clay beds with occasional sand units. The silty clay is gray, brown, green, or blue; either glauconitic or lignitic with thin layers of ferruginous siltstone. The sands are discontinuous, mostly green or gray layers less than 9 m (30 ft) thick. The Cook Mountain Formation contains marine fossils, which in addition to the green sands, distinguish it from the overlying Cockfield Formation and the underlying Sparta Sand.

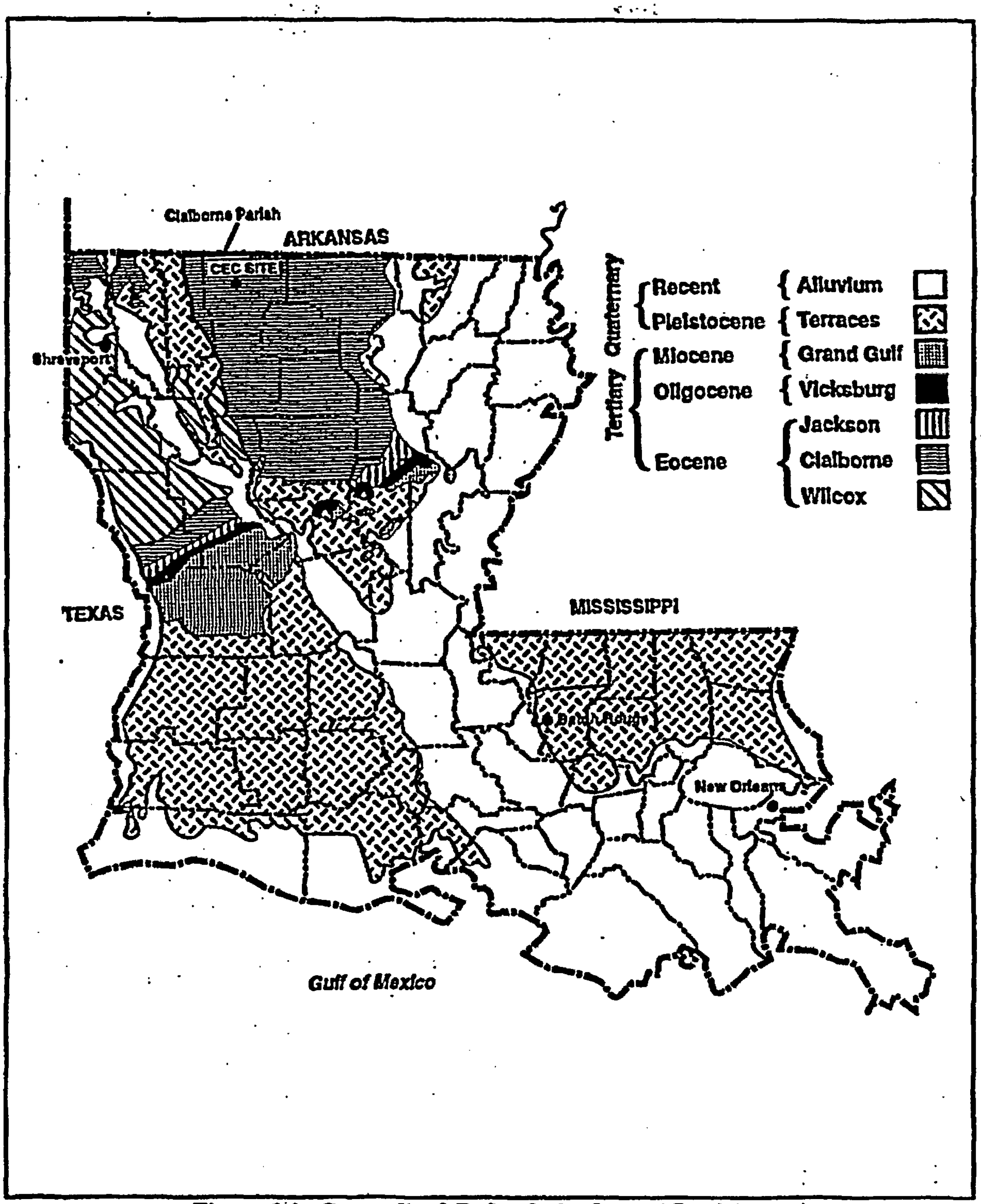

Figure 3.3 Generalized Bedrock Geology of Louisiana (Adapted from Louisiana Geological Survey, 1984)

Table 3.1 Composite Stratigraphic Section of Louisiana (Pope, 1980)

Era	System	Series	Group	Formation	Remarks
CENOZOIC	QUATERNARY	HOLOCENE		Recent alluvium	Forms a veneer on terraces locally.
		PLEISTOCENE		Loess	Fluviate and coastwise terraces at surface; subsurface marine equivalents down-dip zoned on paleontology.
				Prairie	
				Montgomery	
				Bentley	
				Williana	
				Citronelle	
	TERTIARY	PLIOCENE			Not recognized at surface except for Citronelle.
		MIOCENE		Fleming	Subsurface marine beds zoned on paleontology arbitrarily into upper, middle, and lower.
				Catahoula	
		OGLIOCENE		Anahuac	Recognized in subsurface.
				Frio	Mid. Frio (Hackberry) is a subsurface wedge.
			Vicksburg	Nash Creek (W) = Rosenfield (E)	These surface units are not subdivided in the subsurface.
				Sandel	
		EOCENE	Jackson	Mosley Hill	Most of these have both surface and subsurface expression.
				Danville Landing	
				Yazoo	
				Moodys Branch	
			Claiborne	Cockfield	
				Cook Mountain	
				Sparta	
				Cane River	
		PALEOCENE	Wilcox	Carrizo	These are surface units; undifferentiated in the subsurface.
				Sabinetown	
				Pendletown	
				Marthaville	
				Hall Summit	
				Lime Hill	
				Converse	
				Cow Bayou	
				Dolet Hills	
				Naborton	
			Midway	Porters Creek	These units are present only very locally at the surface.
				Kincaid	

Table 3.1 Composite Stratigraphic Section of Louisiana (Pope, 1980) (Continued)

Era	System	Series	Group	Formation	Remarks
MESOZOIC	CRETACEOUS	GULF	Navarro*	Arkadelphia	The only Mesozoic sediments (all upper Cretaceous) that have been identified at the surface are those on only a few piercement salt domes in the northern part of the State.
				Nacatoch	
				Saratoga	
			Taylor*	Marlbrook*	
				Annona*	
				Ozan*	
			Austin*	Brownstown*	
				Tokio*	
			Eagle Ford*	Upper #	
				Lower #	
			Tuscaloosa	Upper	
				Middle	
				Lower	
		COMANCHE	Washita*	South Tyler*	Washita units are present primarily within the salt-dome basins of the Interior Salt Basin (subsurface only).
				Buda*	
				Grayson*	
				Main Street*	
				Weno-Pawpaw*	
				Denton*	
				Fort Worth*	
				Duck Creek*	
				Kiamichi*	
			Fredericksburg*	Goodland*	Fredericksburg and upper parts of the Trinity are not present over highest elements of the Sabine Uplift; these and older Comanche units are also absent over highest elements of the Monroe Uplift.
				Paluxy*	
			Trinity*	Rusk*	
				Ferry Lake*	
				Rodessa*	
				James*	
				Pine Island*	
			Coahuila*	Sligo	
				Hosston	

Table 3.1 Composite Stratigraphic Section of Louisiana (Pope, 1980) (Continued)

Era	System	Series	Group	Formation	Remarks
MESOZOIC (cont'd)	JURASSIC	UPPER	Cotton Valley*	Dorcheat*	# Units proposed by E.G. Anderson (1979) * These units are more properly designated as time-straigraphic rather than rock-stratigraphic, i.e., stage rather than group and substage rather than formation.
				Shongaloo*	
				Bossier	
			Louark*	Haynesville	
				Smackover	
				Norphlet	
		MIDDLE LOWER — LA SERIES #			
	TRIASSIC	UPPER		Eagle Mills	

Upper Paleozoics have been encountered to date in two deep wells: Union Producing Co., A-1 Tensas Delta, Exxon, 1-Boise Southern, Sabine Parish.

3.2.1.2 Local Geology

Geotechnical investigations conducted at the proposed site confirm that sediments encountered within 30 m (100 ft) below ground surface (bgs) are the Tertiary Cockfield and Cook Mountain Formations with some recent alluvial deposits adjacent to local drainages (Westinghouse, 1989; Law Engineering, 1990a; and LES, 1993b). The upper nonmarine unit of the Cockfield Formation is generally found in the highest elevations in the northern area of the site. The lower marine unit, generally found at elevations ranging from 285 to 300 MSL, lies conformably on the upper green silty clay of the Cook Mountain Formation.

Beneath the Cook Mountain Formation lies the Sparta Sand which, in the vicinity of the proposed site, is composed of layers of very fine to medium sand with interbedded silty clay and clay from 150 to 210 m (500 to 700 ft) thick. The Sparta Sand is the principal aquifer in north-central Louisiana, with well yields as high as 6,800 liters per minute [1,800 gallons per minute (gpm)]. The Sparta Sand overlies the Cane River Formation, composed mostly of green glauconitic silt and clay that act as a confining layer between the Sparta Sand and the underlying Wilcox-Carrizo Aquifer. Site stratigraphy, starting with the Cockfield Formation, is presented in Table 3.2. Stratigraphically, all geologic units are present from the middle Tertiary Cockfield Formation through the Jurassic Louann Salt. The depth to the top of the Jurassic Louann Salt is estimated at approximately -4,900 m (-16,000 ft) MSL. The thickness of the salt in the vicinity of Homer is approximately 610 to 760 m (2,000 to

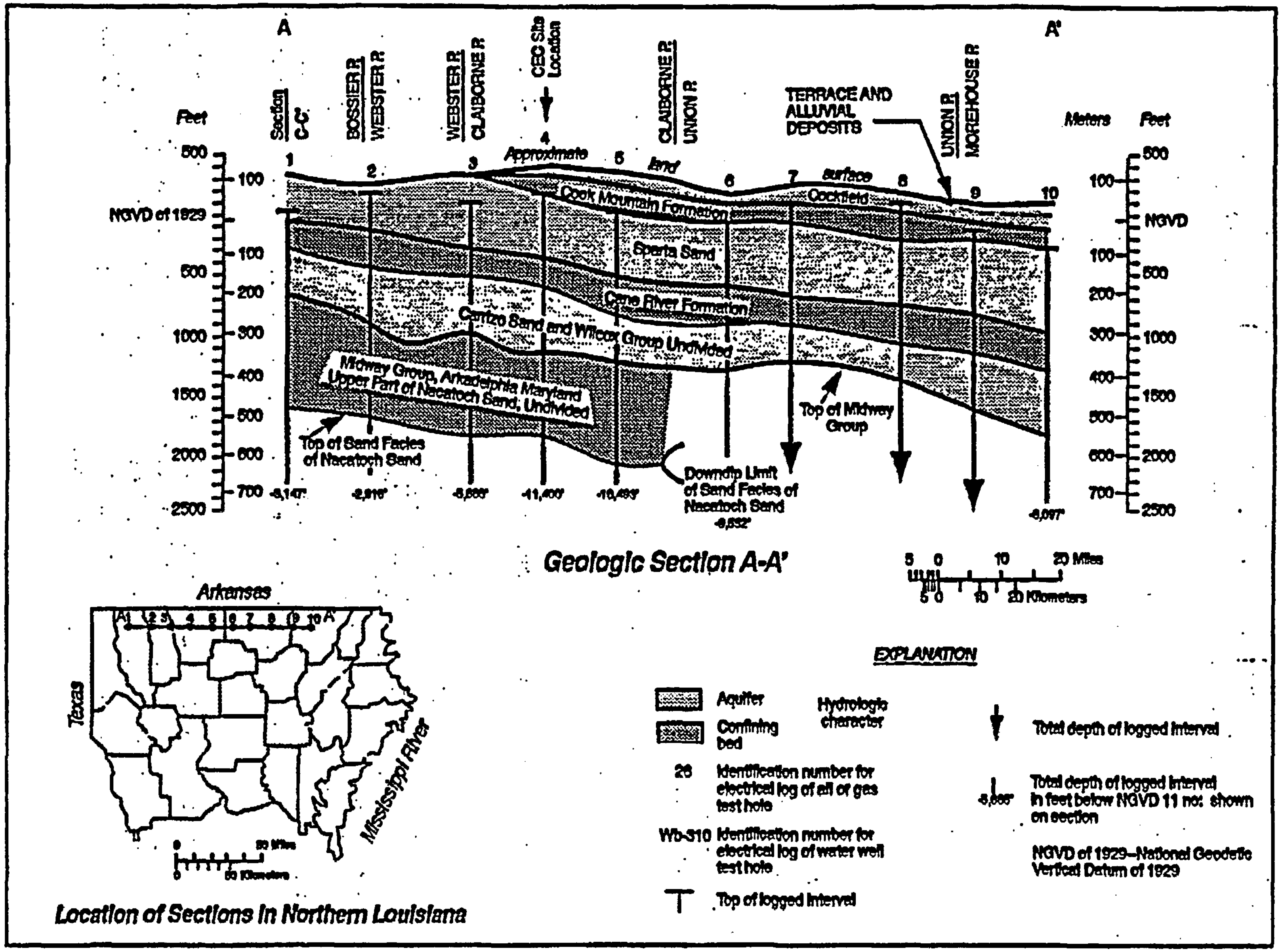

Figure 3.4 Geologic Cross Section of Claiborne Parish (Ryals, 1984)

Table 3.2 Stratigraphy at the Proposed CEC Site (Law Engineering, 1990b)

Formation	Elevation (m MSL*)
Cockfield Formation	+ 107
Cook Mountain Formation	+ 94
Carrizo Formation	- 226
Wilcox Group	- 290
Midway Group	- 381
Nacatoch Formation	- 686
Saratoga Formation	- 741
Eagle Ford Formation	- 881
Tuscaloosa Formation	- 893
Rusk Formation	-1,027
Ferry-Lake Formation	-1,341
Rodessa Formation	-1,463
James Formation	-1,600
Pine Island Formation	-1,701
Sligo Formation	-1,737
Hassatan Formation	-1,774
Cotton Valley Group	-2,728

MSL = mean sea level

2,500 ft), which puts the Triassic basement rock at -5,500 to -5,640 m (-18,000 to -18,500 ft) MSL (Law Engineering, 1990b).

As shown in Figure 3.5, the proposed CEC site lies on the D'Arbonne Platform (also known as the Claiborne Platform) between the north flank of the Louisiana Salt Basin and the southwest flank of the Monroe Uplift. The subsurface stratigraphy consists of nearly horizontal sedimentary rocks with a slight southwesterly dip. No structural faulting is evident at the surface of the site; however, faulting related to subsidence and uplift of salt basins and salt dome intrusion occurred in mid-Tertiary time to the southwest. The site lies on the northeastern flank of the Homer Dome, also known as the Darley High (LES, 1993a).

The faulting that occurred as a result of uplift of the Homer Salt Pillow has displaced bedrock to the southwest several hundred feet (LES, 1994a). The Sparta Sand has been displaced upward and is exposed at the surface in this area. Geologic investigations in the immediate vicinity of the site indicate that none of the strata deposited since the Tertiary have been displaced by faulting (Law Engineering, 1990b).

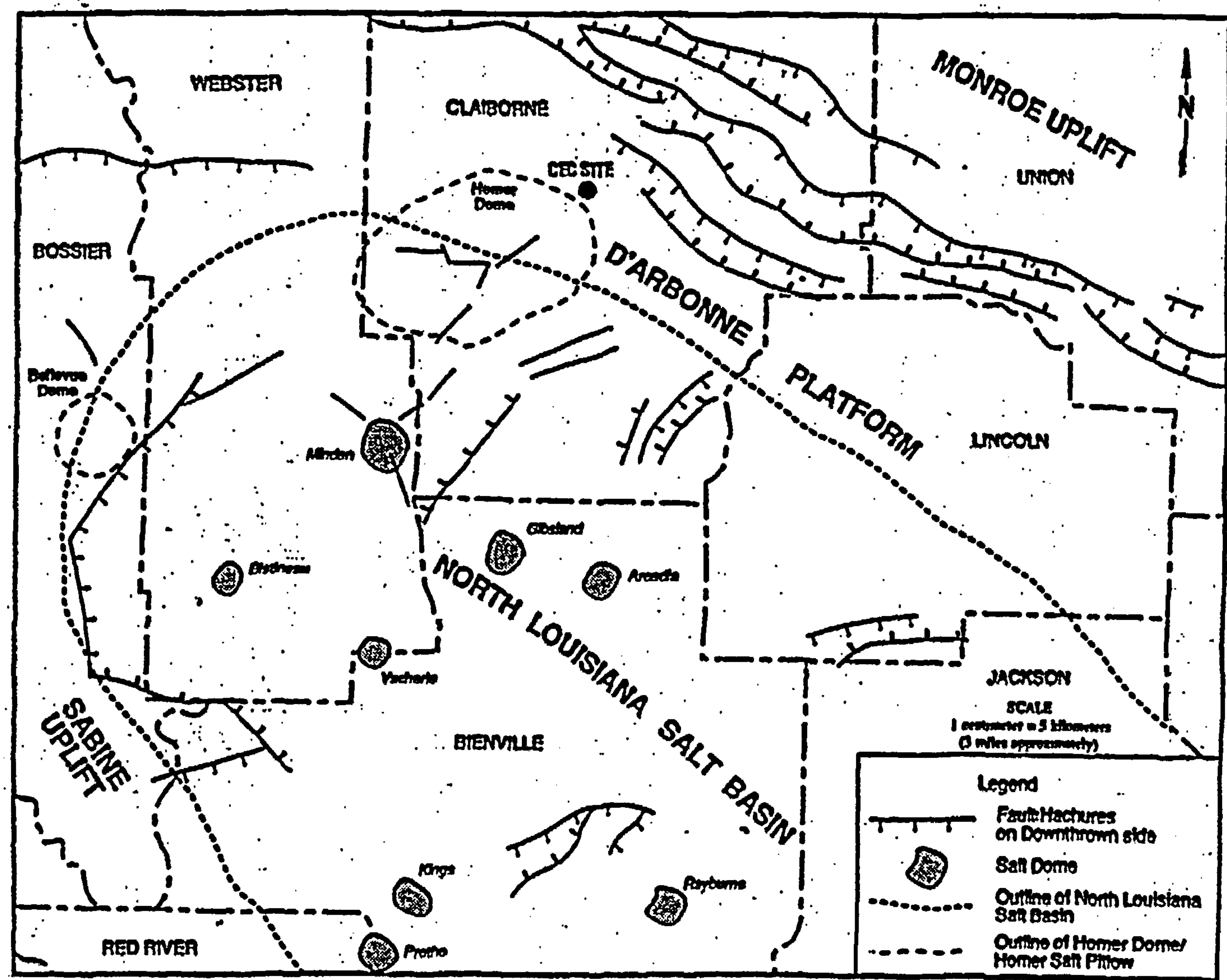

Figure 3.5 Structural Geology of the CEC Site and Vicinity (Law Engineering, 1990a and Chenoweth, 1984)

As a result of the depositional processes operating throughout the Mesozoic era (Anderson, 1979), significant oil and gas deposits are found throughout Louisiana. The nearest oil fields are the Homer Oil Field, 11 km (7 miles) to the southwest; the Haynesville Oil Field, 19 km (12 miles) to the northwest; and the Lisbon Oil Field, 14 km (9 miles) to the southeast of the proposed site.

There are 31 active oil/gas wells within an 8 km (5 mile) radius of the CEC site. The nearest oil and gas well is located 27.5 m (90 ft) south of the southwest corner of the proposed site boundary (Conolly, 1990). The well is drilled to a depth of approximately 2,900 m (9,400 ft). Preliminary investigations indicate that a drilling fluid pit existed near the well. The Louisiana Department of Natural Resources (LDNR) has classified the pit as closed, however, no documentation exists to certify that the pit was closed properly. The operator of the well has been cited by LDNR for discharging "nonhazardous oil field waste," or oil field brine, directly to a surface drainage. Soils, surface water sediments, and groundwater in the vicinity of this well were analyzed to determine if pollutants from the well have migrated to the proposed CEC site (LES, 1994a). Samples were analyzed for benzene, toluene, ethyl benzene, xylene (BTEX), total petroleum hydrocarbons (TPH), and priority pollutant metals (Shipp, 1989). The results indicate that no BTEX or metal compounds were detected above regulatory limits. However, one surface water sample contained silver at 0.06 mg/l, which is slightly above the regulatory limit of 0.05 mg/l. TPH were detected in soils and sediment samples. In the area of the oil and gas well, concentrations of TPH range from 20 to 104 parts per million (ppm), indicating that contaminants may be migrating onto the proposed site from the oil and gas well (Shipp, 1989; LES, 1993a).

There are four distribution pipelines within the 8 km radius of the CEC. None of these pipelines cross the site (LES, 1993a). The closest to the site is a pipeline that transmits natural gas. The closest point is located approximately 600 m (2000 feet) southwest of the TSA. A 15-cm (6-in) gas crude oil transmission line is located approximately 1.3 km (.8 mile) north of the CEC site.

Other mineral resources in the vicinity of the proposed CEC site include salt and associated sulphur deposits found in the salt domes. However, no production of salt or sulphur is presently ongoing in the North Louisiana Salt Basin. Other minor geologic resources include lignite and iron ore in the form of glauconite and deposits of construction materials such as sand, gravel, and limestone. Currently, market demands for these resources are small (Law Engineering, 1990a).

Analyses for naturally occurring radionuclides in Louisiana soils, including potassium (^{40}K), cesium (^{137}Cs), uranium (^{238}U), and thorium (^{232}Th), indicate that radionuclide concentrations can be correlated with soil suborder (Merriweather, et al., 1988). The lowest concentrations of naturally occurring radionuclides in the State are found in the Udults soil suborder, at the proposed CEC site.

3.2.2 Soils

The soils found at the proposed site, developed from the weathering of the Cockfield Formation, are of the Gliead and Shubuta soil associations (Law Engineering, 1990a). Figure 3.6 is a soils map of the site, indicating the presence of the Sacul-Wolfpen-Darley soil unit (Kilpatrick and Henry, 1989). This unit generally consists of gently sloping to moderately steep, moderately well-drained soils that have a loamy, gravelly, or sandy surface layer and a clayey or loamy subsoil. The predominant soil series found at the site are the Sacul and Wolfpen series. Other soils include an area of Angie series soil in the center of the site, a small area of Darley series soil in the southeast corner of the site, and an area of the Iuka-Dela Complex soil downstream of Lake Avalyn.

The Sacul series soils found at the site generally have a clayey subsoil, low permeability, high shrink-swell potential, and low strength for roads. The Wolfpen series soils are found on broad ridgetops and uplands and have low shrink-swell potential. Cutbanks in this soil are not stable and are subject to slumping. In general, Angie series soils are gently sloping and moderately well drained. They are characterized by high water content, low permeability, clayey subsoil, high shrink-swell potential, and low strength for roads. The Darley series soils consist of gravelly fine sandy loam. This series is similar to the Angie series soils except for the generally greater steepness of slopes and the presence of ironstone layers. The Iuka-Dela series soils, found in level floodplains of major streams, are subject to frequent flooding from stream overflow.

3.2.3 Seismology

The proposed site is located in the Interior Salt Basin seismotectonic region (Figure 3.7). This area has historically experienced minimal seismicity and the region is generally considered aseismic. The Uniform Building Code (UBC) Seismic Zonation Map places the site in Seismic Zone 1 (Figure 3.8), which is characterized by minor damage from distant earthquakes. A historical list of earthquakes occurring within 320 km (200 mi) of the proposed site is provided in Table 3.3. The largest recorded earthquake in the vicinity of the site occurred in 1911; it had a magnitude of 4.6 at a distance of 169 km (105 miles).

The estimated Modified Mercalli (MM) ground-shaking intensity from this earthquake was VII. In addition, 10 other magnitude 4.0 through magnitude 4.4 earthquakes occurred within 320 km (199 miles) of the site with MM intensities of IV to VI.

Historical data also indicate that several large earthquakes with epicenters located at great distances may have been felt at the site (Law Engineering, 1990a). The New Madrid earthquakes of 1811-1812 may have produced intensity VII shaking at the site. Other large earthquakes occurring near Memphis, Tennessee; Charleston, South Carolina; and New Madrid, Missouri may have been felt at the site. A probabilistic seismic hazard analysis was performed by Law Engineering (1990a) to determine the probability and magnitude of maximum ground acceleration at the site as a result of seismic events. The

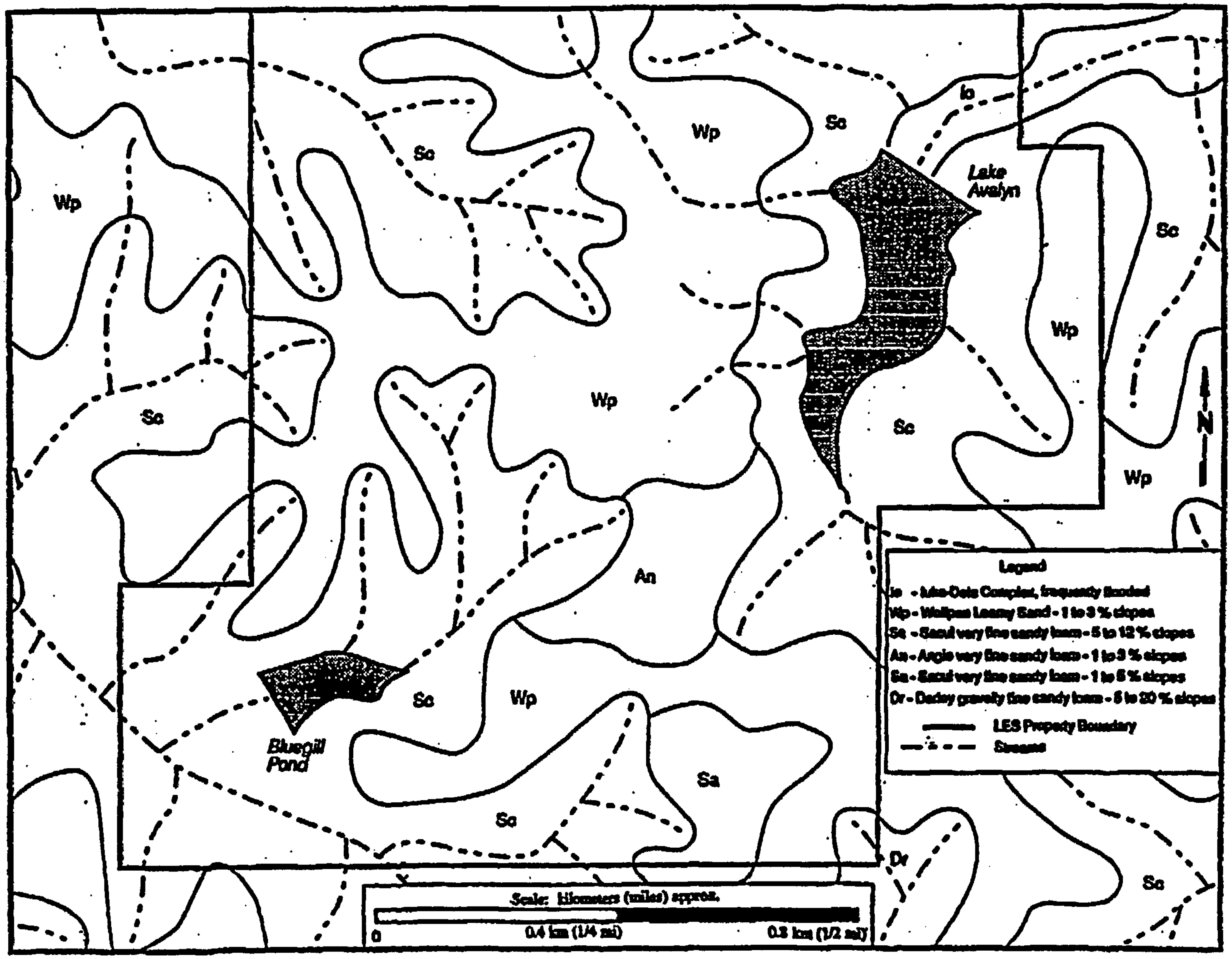

Figure 3.6 Map of Soils in the Vicinity of CEC Site (Kilpatrick and Henry, 1989)

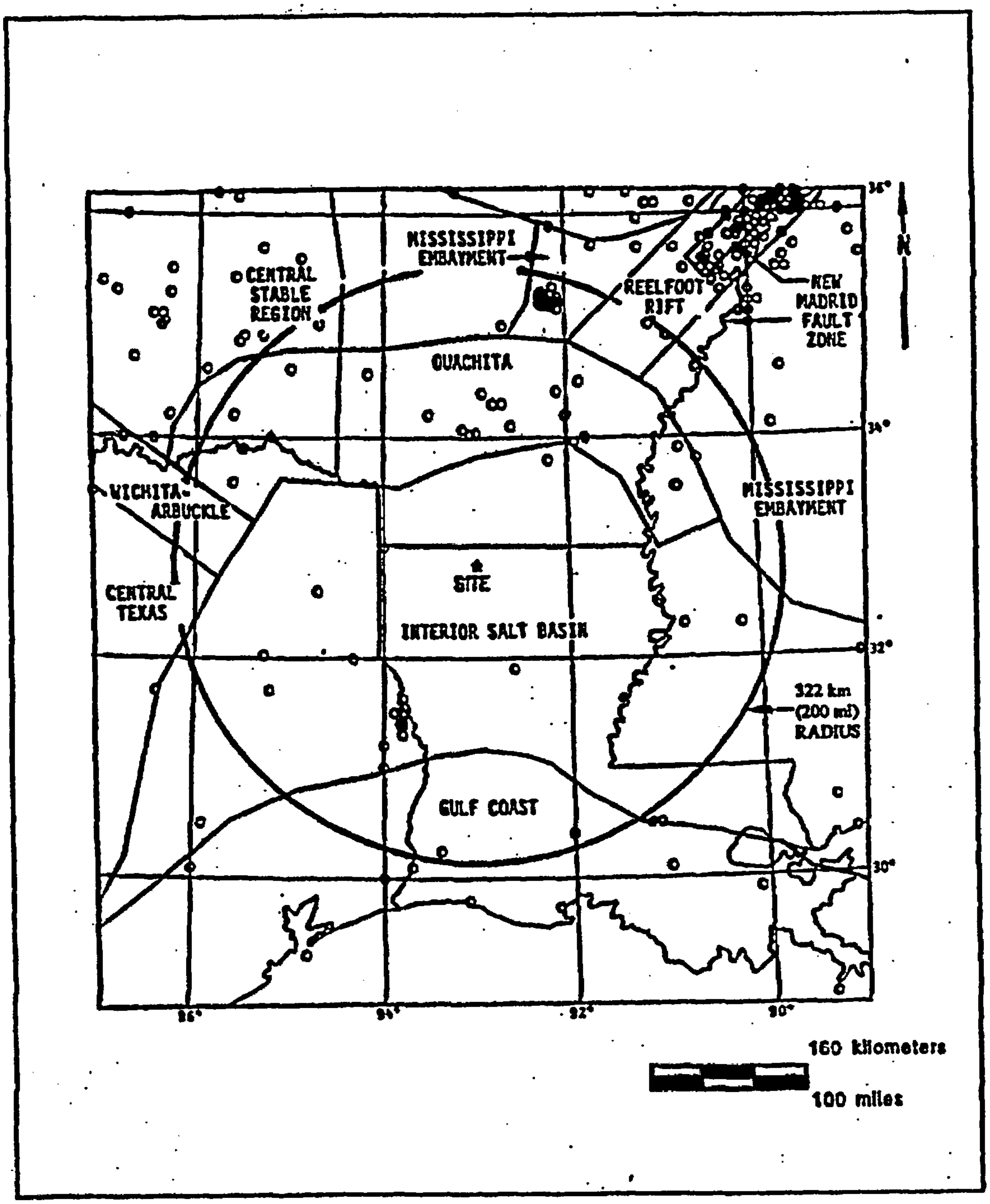

Figure 3.7 Map of Seismotectonic Regions in the Vicinity of the Proposed CEC Site (Law Engineering, 1990a)

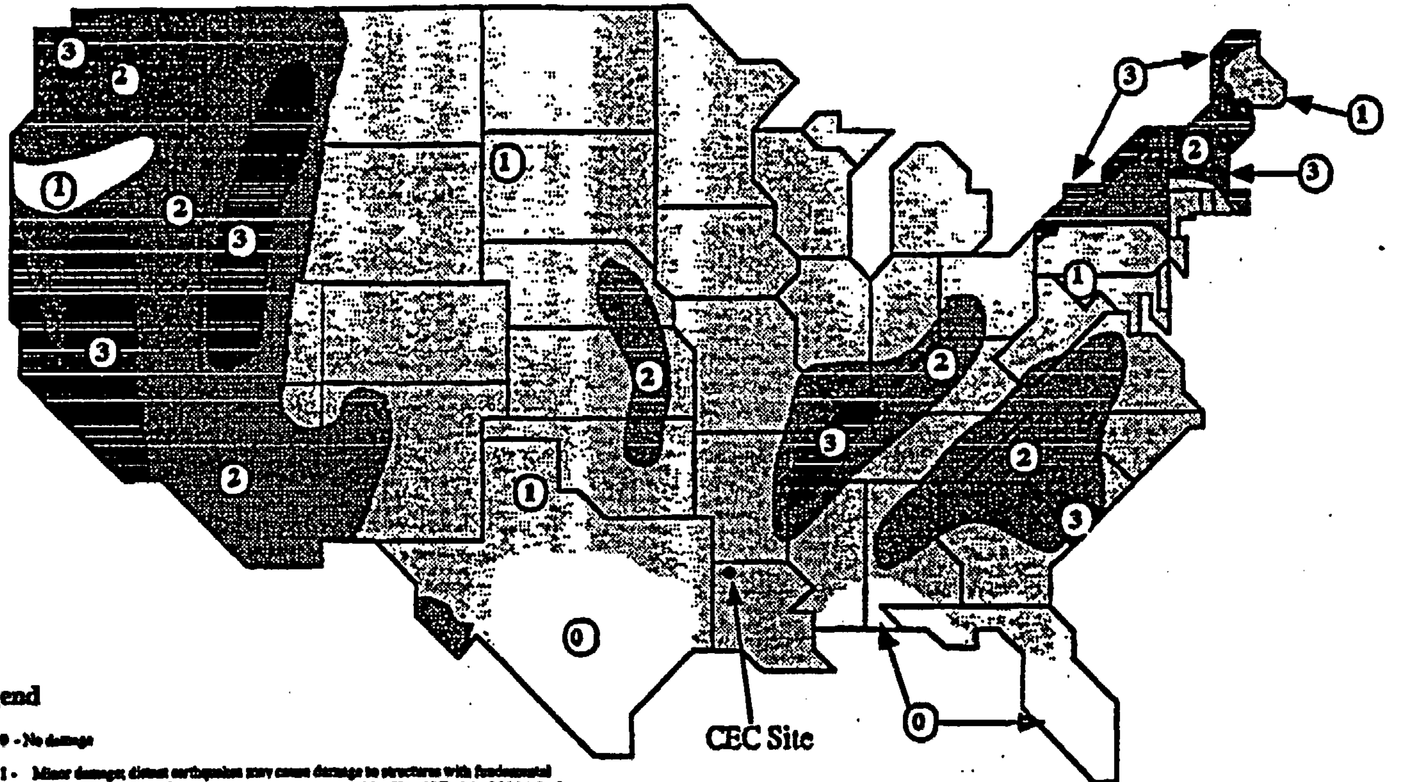

Figure 3.8 Seismic Risk Map of the United States (Adapted from Algermissen, 1968 and International Conference of Building Officials, 1988)

Table 3.3 Historical Earthquakes Occurring within 320 km (200 miles) of the Proposed CEC Site (LES, 1994a)

Year	Date	Time	Latitude N	Longitude W	Distance (km)	Magnitude	Felt Area (km^2)	Intensity (Io)
1886	Jan 22	16:38	30.40	92.00	287	2.5		II
1891	Jan 8	6:00	31.70	95.20	244	3.8		VI
1898	Jan 27	1:35	34.60	90.60	295	3.1		IV
1905	Feb 3	0:00	30.50	91.10	315	3.5		V
1911	Mar 31	16:57	34.00	91.80	169	4.6	259	VII
1911	Mar 31	18:10	33.80	92.20	129	3.5	16	IV-V
1918	Oct 4	9:21	35.00	91.10	296	4.0	207	IV-V
1927	Nov 13	16:21	32.30	90.20	267	3.4	21	IV
1930	Oct 16	12:30	34.30	92.70	164	2.5		II
1930	Nov 16	12:30	34.30	92.80	163	3.3	2331	V
1934	Apr 11	17:40	33.90	95.50	262	3.6	21	V
1936	Mar 14	17:20	34.00	95.20	243	3.4	5	V
1938	Apr 26	5:42	34.20	93.50	159	3.1		IV
1939	Jun 19	21:43	34.10	92.60	145	4.1	171	V
1940	Dec 2	16:16	33.00	94.00	97	3.1		IV
1941	Jun 28	18:30	32.30	90.80	213	3.0		III-IV
1947	Sep 20	21:30	31.90	92.60	110	3.3		IV-V
1952	Oct 17	15:48	30.10	93.70	312	3.1		IV
1956	Apr 2	16:03	34.20	95.60	286	3.5	13	V
1957	Mar 19	16:37	32.60	94.70	163	4.0	122	V
1957	Mar 19	17:41	32.60	94.70	163	2.5	8	III
1957	Mar 19	22:36	32.60	94.70	163	2.5	8	III
1957	Mar 19	22:45	32.60	94.70	163	2.5	8	III
1958	Nov 19	18:15	30.50	91.20	310	3.2	2072	V
1960	May 4	16:31	34.20	92.00	176	3.8		IV
1961	Apr 26	7:05	34.60	95.00	271	3.8	16	III
1961	Apr 27	3:00	34.60	95.00	271	3.0		II
1961	Apr 27	5:00	34.60	95.00	271	3.0		II
1961	Apr 27	7:30	34.90	95.30	314	4.1	52	V
1963	Feb 7	21:18	34.40	92.10	192	3.4		
1964	Apr 24	1:20	31.38	93.81	180	3.3		V
1964	Apr 24	7:33	31.42	93.81	176	3.6		IV
1964	Apr 24	7:47	31.38	93.80	180	3.3		
1964	Apr 24	12:07	31.48	93.79	169	3.2		IV
1964	Apr 24	12:54	31.30	93.80	188	3.0		
1964	Apr 26	3:24	31.55	93.78	162	3.3		
1964	Apr 27	21:50	31.30	93.80	188	3.2		IV
1964	Apr 28	0:24	31.50	93.80	168	3.1		
1964	Apr 28	0:30	31.40	93.82	179	3.3	2072	V
1964	Apr 28	21:18	31.63	93.80	155	3.4	8	VI
1964	Apr 30	21:30	31.20	94.00	206	3.0		III
1964	May 2	6:34	31.30	93.80	188	3.2		
1964	May 3	3:24	31.30	93.08	188	3.0		V
1964	May 7	20:01	31.20	94.00	206	3.2		V
1964	Jun 2	23:00	31.30	94.00	178			V

W = West N = North

Table 3.3 Historical Earthquakes Occurring within 320 km (200 miles) of the Proposed CEC Site (LES, 1994a) (Continued)

Year	Date	Time	Latitude N	Longitude W	Distance (km)	Magnitude	Felt Area (km^2)	Intensity (Io)
1964	Jun 3	2:27	31.50	93.90	172	3.1		IV
1964	Jun 3	9:37	31.00	94.00	226	3.6		III-IV
1964	Aug 16	11:35	31.40	93.80	178	3.0		IV
1967	Jun 4	16:14	33.55	90.84	214	4.3	142	VI
1967	Jun 29	13:57	33.55	90.81	217	4.0		V
1969	Jan 1	23:35	34.99	92.69	241	4.4	155	VI
1973	Jan 8	9:11	33.80	90.60	246	3.5		III
1973	May 25	14:40	33.90	90.80	234	3.4		III
1973	May 25	14:42	33.90	90.80	234	3.2		
1973	Nov 18	10:03	35.00	94.70	288	3.1		
1974	Feb 15	22:32	34.04	92.98	133	3.5		III
1974	Feb 15	22:35	34.07	93.12	137	3.4		III
1974	Feb 15	22:49	34.03	93.04	132	3.8	41	V
1974	Dec 13	5:03	34.49	91.86	211	3.1		V
1975	Jan 2	9:19	34.90	90.90	299	3.0		II-III
1977	Jun 2	23:29	34.56	94.17	221	3.6		VI
1977	Nov 26	4:18	34.39	92.91	173	3.1		IV
1978	Sep 23	7:34	33.96	91.92	159	3.1		V
1981	Jun 9	1:46	31.99	94.32	157	3.2		III
1981	Nov 6	12:36	32.02	95.26	233	3.2	2.6	IV
1982	Jan 18	1:23	35.23	95.28	274	3.4		
1982	Jan 18	2:32	35.19	92.23	270	3.3		IV
1982	Jan 19	4:39	35.18	92.25	269	3.5		IV
1982	Jan 20	14:01	35.14	92.08	269	3.5		IV
1982	Jan 21	0:33	35.18	92.25	269	4.2		V
1982	Jan 21	1:13	35.18	92.21	270	3.5		
1982	Jan 21	15:45	35.17	92.14	270	3.8		III
1982	Jan 22	23:54	35.25	92.29	275	3.7		
1982	Jan 24	3:22	35.22	92.22	274	4.3		V
1982	Jan 27	23:29	35.21	92.24	272	3.2		
1982	Feb 1	5:55	35.20	92.28	270	3.6		IV
1982	Feb 1	7:25	35.19	92.25	270	3.6		
1982	Feb 12	5:32	35.27	92.29	278	3.0		
1982	Feb 24	19:27	35.29	92.25	281	3.9		V
1982	Mar 1	0:12	35.20	92.11	274	4.1		V
1982	Apr 21	21:17	35.18	92.24	269	3.5		
1982	May 31	17:49	35.21	92.25	272	2.9		IV
1982	May 31	18:21	35.20	92.23	271	3.5		
1982	Jun 30	16:22	35.34	92.13	289	3.3		
1982	Jul 5	4:13	35.22	92.21	274	3.5		
1982	Sep 27	10:22	35.22	92.11	277	3.0		
1982	Nov 17	19:00	35.20	92.07	276	3.2		
1982	Nov 21	16:35	35.25	92.08	281	3.5		
1983	Jan 19	2:30	35.28	92.16	282	3.9		
1983	Mar 30	4:15	35.20	92.15	273	3.2		
1983	Oct 16	19:40	30.24	93.39	292	3.8		III
1984	Sep 27	13:30	35.25	92.21	277	3.4		IV

W = West N = North

approach was based on an evaluation of the seismic source zones, or seismotectonic regions, that might potentially affect the site. The seismotectonic regions within 320 km (200 miles) of the site include:

- Interior Salt Basin Region
- Gulf Coast Region
- Central Texas Region
- Ouachita Region
- Wichita-Arbuckle Region
- Reelfoot Rift
- New Madrid Fault Zone
- Central Stable Region
- Mississippi Embayment

A probabilistic seismic hazard analysis was performed to compute the return periods, or probability of recurrence, of specific horizontal and vertical ground acceleration at the site, based on the expected occurrence of earthquakes in each seismic zone. The results are expressed in maximum or peak acceleration and converted to effective ground acceleration, which is more representative of damage associated with sustained acceleration over a period of time. Estimates of peak and effective ground acceleration for 100-, 500-, and 1000-year recurrence intervals were developed by Law Engineering and are presented in Table 3.4 (Law Engineering, 1990a).

Table 3.4 Estimated Ground Acceleration at the Proposed CEC Site (LES, 1994a)

Return Period (Years)	Peak Acceleration in Rock (cm/s^2 [g_a])		Effective Acceleration in Rock (cm/s^2 [g_a])	
	Horizontal	Vertical	Horizontal	Vertical
100	17 (0.017)	12 (0.012)	12 (0.012)	8 (0.008)
500	45 (0.046)	32 (0.033)	32 (0.033)	22 (0.022)
1000	63 (0.064)	45 (0.046)	44 (0.045)	32 (0.033)

g_a = gravitational acceleration

The results of the analyses for the 500-year recurrence interval indicate that four seismic source zones are responsible for 90 percent of the seismic hazard at the site: the New Madrid Fault Zone (28 percent), the Ouachita Region (23 percent), the Interior Salt Basin (22 percent), and the Reelfoot Rift (19 percent). Similar results were obtained for the 100- and 1000-year recurrence intervals. These results suggest that the greatest hazard to the site is represented by moderate- to large-sized earthquakes occurring at distances of 100 km (60 miles) or more from the site (Law Engineering, 1990a).

In addition, it is evident from Table 3.4 that the largest peak vertical acceleration (45 cm/s^2) and the largest peak horizontal acceleration (63 cm/s^2) would result from the 1000-year event. The design basis earthquake (DBE) is used by Louisiana Energy Services (LES) to represent the level of seismic hazard, or peak acceleration in rock, at a site associated with earthquakes with a return period of 500 years. Because several seismic source zones may potentially affect the site, three DBEs were developed for the proposed CEC site: near-field, mid-field, and far-field earthquakes. Characteristics of these DBEs are provided in Table 3.5.

Table 3.5 Characteristics of Three Design Basis Earthquakes (DBEs) for the Proposed CEC Site (LES, 1994a)

DBE	m_b	Epicentral Distance from Site (km [mi])	Peak Horizontal Acceleration (cm/s^2 [g_a])	Seismic Source Zone
Near-field	4.3	15 (9.3)	45 (0.045)	Interior Salt Basin
Mid-field	5.7	105 (165)	40 (0.04)	Ouachita Region
Far-field	6.7	356 (221)	22 (0.022)	New Madrid Fault Zone

m_b = magnitude

In addition to the DBE, the Maximum Credible Earthquake (MCE) is used by LES to represent the largest conceivable seismic event that could occur in the site tectonic region. In 1989, Westinghouse computed the MCE based on the MM intensity of the 1811-1812 New Madrid earthquakes. Using the relationship between the MM and the magnitude of an earthquake developed by Richter in 1956, Westinghouse estimated the MCE to be a magnitude 5.7 event for Claiborne Parish. The MCE can be used, in turn, to compute the expected peak ground acceleration (Houser, 1970; Nuttli and Herrman, 1982). Based on these methods, the peak ground acceleration for a magnitude 5.7 MCE is 1.96 m/s^2 or 0.2 gravitational acceleration (g_a) with a recurrence interval of 500 years (Westinghouse, 1989).

An additional estimate of the expected maximum ground acceleration was obtained from two sets of seismic zone maps developed by the National Earthquake Hazards Reduction Program (NEHRP). One set of maps is similar to the UBC map provided in Figure 3.8 and indicates the site has an effective peak gravitational acceleration of 59 cm/s^2 (0.06 g_a). The other set of NEHRP maps, based on a recent United States Geological Survey (USGS)

study, gives a maximum ground acceleration for the site of approximately 39 cm/s^2 (0.04 g_a) for the 475-year return period, and 59 cm/s^2 (0.06 g_a) for the 2,300-year return period.

The apparent discrepancy between the MCE peak acceleration (196 cm/s^2, or 0.2 g_a, for 500 years) and the NEHRP maximum acceleration (39 cm/s^2, or 0.04 g_a, for 500 years) is most likely due to the conservative nature of the relationship between earthquake magnitude and ground acceleration used to compute MCE peak acceleration; the ground accelerations predicted by this method have been shown to be greater than actual observations. In addition, the method of predicting earthquake magnitude based on MM intensity has been shown to be conservative; the method tends to overpredict earthquake magnitude.

Further analysis of the seismic hazard potential, including the development of vertical and horizontal response spectra used to estimate ground motions at the site, was performed by Law Engineering (1990a). The response spectra were calculated based on the estimated near-field, mid-field, and far-field DBEs, and the site-specific seismic data from downhole seismic surveys, boring logs, geotechnical measurements, and geophysical logs from nearby oil fields. The site-specific seismic data were used to determine the amount of damping or amplification of seismic waves that would be produced by soils at the site.

The results of the response spectra analysis indicate that at seismic wave frequencies below 1.5 Hertz, the large far-field event dominates ground motion considerations. At seismic wave frequencies above 1.5 Hz, the mid-field event dominates. The results also indicate that, in general, the soil characteristics of the site result in amplification of the amplitude of seismic wave frequencies less than 5.0 Hz, and reduction, or damping, of seismic waves at higher frequencies (Law Engineering, 1990a).

3.3 Hydrology

The hydrology of a site is characterized by its surface water resources and groundwater resources. A description of the surface water resources present at the proposed site, including streams, ponds, and lakes, is presented in Section 3.3.1. The subsurface water resources are discussed in Section 3.3.2, including characterization of the shallow groundwater and the Sparta Sand Aquifer, which is the major source of water in Claiborne Parish.

3.3.1 Surface Water Resources

The proposed site is located in the western portion of the Ouachita River Basin as shown in Figure 3.9. The surface water resources of the site and vicinity include small streams that flow east and west from the site and two manmade water bodies, Bluegill Pond and Lake Avalyn (Figure 3.2). Surface water that flows from the site to the west and northwest discharges to Cypress Creek. Cypress Creek flows southwest for a distance of 7 km (4.5 miles) prior to joining Beaver Creek, which flows south into Lake Claiborne. Lake Claiborne was created for industrial development and recreation by the damming of Bayou

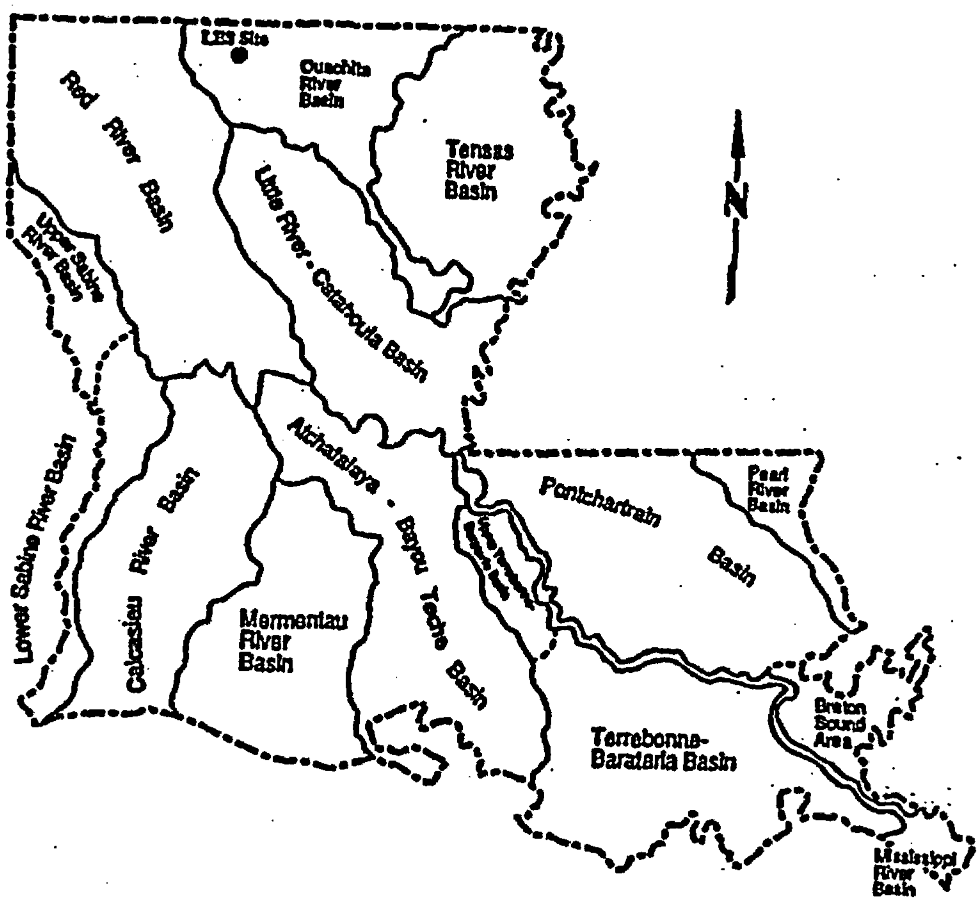

Figure 3.9 Map of Louisiana River Basins (Emmer et al., 1983)

D'Arbonne in 1966. Lake Avalyn outflows through an overflow standpipe exiting downstream of the earth dam. Surface water flowing east from the site forms the headwaters of McCasland Creek, which eventually discharges into the Middle Fork of Bayou D'Arbonne, a Louisiana Natural and Scenic State Stream (Emmer et al., 1983). Outflows from Bluegill Pond combine with an unnamed stream that flows onto the site from the south, then to the west. This stream forms a tributary of Cypress Creek, which then flows southwest into Lake Claiborne. As shown in Table 3.6, the streams on the site are generally intermittent but have recorded flow rates up to a few liters per second. Flow is generally greater in onsite streams in January than in July and August. In August 1990, the downstream reaches of both McCasland and Cypress Creeks were observed to be dry (LES, 1994a). The proposed CEC site is located approximately 5 km north and upstream from Lake Claiborne. The elevation of the proposed site is approximately 98 m (324 ft) MSL, which is approximately 42 m (140 ft) above the elevation of Lake Claiborne, 55 to 56 m (183 to 185 ft) MSL. In addition, dams constructed for flood control are constructed to control the release of water downstream from the dam. Therefore, Lake Claiborne was not constructed to control floods upstream from the dam that forms the lake.

As shown in Figure 3.10, Bluegill Pond and Lake Avalyn have surface elevations of 84 m and 90 m (275 ft and 297 ft), respectively. The Drainage Basin area of Bluegill Pond is approximately 1 hectare (2.6 acres), and Lake Avalyn is approximately 68 hectares (170 acres). Depth surveys of these two lakes indicate that the volume of Bluegill Pond is about 22,000 m^3 (780,000 ft^3) and the volume of Lake Avalyn is about 113,300 m^3 (4,000,000 ft^3) (LES, 1994a and 1992a). Discharge from Bluegill Pond was less than 28 liters per second (1 ft^3/sec) in both January and May of 1990. Discharge from Lake Avalyn was measured at 68 liters per second (2.4 ft^3/sec) in January 1990, and at 47 liters per second (1.65 ft^3/sec) in May 1990. Both Lake Avalyn and Bluegill Pond receive water from precipitation runoff and groundwater discharge.

Sediment samples taken near the dam in Bluegill Pond were found to be dark brown to black cohesive clays rich in organic matter. Upgradient sediment samples collected near the inflow of Bluegill Pond were less cohesive and contained larger amounts of organic matter such as leaves. No chemical analyses of these sediments were conducted. Sediment samples taken at equal intervals along the center of Lake Avalyn revealed the existence of hard, dark gray clays closest to the dam, which grade progressively into softer grayish brown muds with increasing amounts of organic matter at the inflow of the lake (LES, 1994a).

Analytical data from water samples taken in the Lake Avalyn Drainage Basin and the Bluegill Pond Drainage Basin are provided in Table 3.7 and Table 3.8, respectively. Analyses of unfiltered water samples taken from Bluegill Pond indicate the presence of metals and other constituents at or below regulatory levels (LES, 1994a, 1993b, and 1992a). Similarly, analyses of unfiltered samples from Lake Avalyn indicate that constituents were either not detected, or were detected at or below regulatory levels. Specifically, antimony, beryllium, nickel, nitrate, nitrite, selenium, silver, and thallium were not detected in any water samples in the Lake Avalyn Drainage Basin.

Table 3.6 Estimated Surface Water Flow Rates in 1990 for Streams within the Immediate Vicinity of the Proposed CEC Site (LES, 1994a)

Surface Water Location	Discharge (liters/sec) January 1990	May 1990	July 1990
Lake Avalyn Drainage Basin			
Southern flow to Lake Avalyn	17	4.5	NE
Discharge from Lake Avalyn	68	47	2
Bluegill Pond Drainage Basin			
Total flow into Bluegill Pond	13	11	NE
Discharge from Bluegill Pond	19	14	NE
Flow in tributary from southwest corner of LES property to CEC site	40	16	NF
Flow at the southwest property boundary after confluence of Bluegill Pond discharge with the tributary from the southwest	54	NE	6
Northwest Drainage Basin			
Flow in tributary on northwest corner of LES property	9	NE	NF

NE = not estimated.
NF = no flow identified; standing water only.

Water samples taken by LES in May 1990 (Table 3.9) indicate that both lakes were thermally stratified, and samples analyzed for dissolved oxygen indicate that the lake bottoms may become somewhat anoxic in the summer (LES, 1994a). In January, the pH of Lake Avalyn was low (5.3) and may have resulted from reduced photosynthetic activity during the winter and the presence of pine needle litter in and around the lake. The low alkalinity of both lakes indicates that they have little buffering capacity. High turbidity readings in Bluegill Pond indicate a large amount of suspended solids, most likely due to the recent deforestation in this Drainage Basin (LES, 1994a).

Additional water quality data (LES, 1993b) for Lake Avalyn and Bluegill Pond were generated between 1991 and 1993, and are presented in Table 3.9 and Table 3.10, respectively. These most recent water chemistry data indicate that Lake Avalyn tends to be acidic, thus its buffering capacity is limited. The pH values were below the regulatory standards for the State of Louisiana (pH = 6.0-8.5). The lake bottom is nearly anaerobic

Figure removed under 10 CFR 2.390.

Table 3.7 Water Chemistry of Lakes at the CEC Site from May to August 1990 (LES, 1993a)

Chemical Data for Samples Collected from Lake Avalyn Drainage Basin (mg/l)

Chemical Parameter	Sample Locations[a]							
	1 Inflow		2a Lake Surface Water		2b Lake Bottom Water		3 Outflow	4 Outflow(Dwnstr)
Calcium	1.4	1.3	1.2	1.2	1.6	NA	1.6	1.8
Magnesium	0.76	0.69	0.55	0.56	0.57	NA	0.57	0.7
Potassium	1.2	1.4	1.0	1.0	1.7	NA	1.7	1.8
Sodium	2.6	2.3	1.4	1.4	1.4	NA	1.4	1.8
Hardness ($CaCO_3$)	6.6	6.1	5.3	5.3	6.3	NA	6.3	7.4
Silver	<0.08	<0.08	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Beryllium	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	<0.8	<0.8	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Zinc	0.046	0.036	0.010	0.013	0.016	0.025	0.020	0.011
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	0.00064	0.00016	<0.0001	<0.0001
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	<0.0020	<0.0020	<0.0020	<0.0020	<0.0010	0.0012	0.0012	0.0012
Selenium	<0.004	<0.004	<0.004	<0.004	<0.002	<0.002	<0.002	<0.002
Cadmium	0.00048	0.00041	0.00022	0.00025	0.00023	0.00028	0.00025	0.00038
Chromium	0.0030	0.0022	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	<0.0010
Copper	0.0026	0.0026	0.0023	0.0020	0.0039	0.0038	0.0025	0.0018
Nickel	<0.0060	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Lead	0.0062	0.0036	<0.0020	<0.0020	0.0035	0.0038	0.0028	0.0026
Sulfate	11	11	8.8	7.7	NA	NA	8.3	9.1
Total Suspended Solids	10	12	<4.0	4.0	NA	NA	11	6.0
Total organic carbon	20	20	11	11	13	13	12	12
Nitrate & nitrate	<0.05	<0.05	<0.05	<0.05	NA	NA	<0.05	<0.05
Chloride	5.2	5.2	2.6	2.7	NA	NA	2.7	3.2
Ammonia nitrogen	<0.05	<0.05	<0.05	<0.05	NA	NA	<0.05	<0.07
Total Phosporus	0.024	0.024	0.021	0.021	0.032	0.035	0.026	0.030

[a] See Figure 3.2 for sample locations.
NA = Not analyzed

Table 3.7 Water Chemistry of Lakes at the CEC Site from May to August 1990 (LES, 1993a) (Continued)

Chemical Data for Samples Collected from Bluegill Pond Drainage Basin (mg/l)

Chemical Parameter	Sample Locations[a] 5 Inflow at the Eastern Point of the Pond		6a Pond Surface Water		6b Pond Bottom Water	7 Outflow Around the Southern Side of the Pond		8 Site Drainage Stream		9 Outflow at Western Property Boundary	10 Cypress Creek 2.4 km Downstream from Bluegill Pond
Calcium	12	12	14	14	18	14	14	18	18	16	22
Magnesium	0.88	0.89	0.90	0.90	0.62	0.90	0.89	1.0	0.98	0.81	1.2
Potassium	2.0	2.0	3.2	3.2	1.9	3.2	3.1	1.8	1.7	NA	NA
Sodium	2.6	2.7	2.0	1.9	1.4	1.9	1.9	4.2	4.4	2.8	2.1
Hardness ($CaCO_3$)	6.6	6.7	7.2	7.2	7.0	7.2	7.2	8.6	8.5	7.3	10.4
Silver	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.040	<0.040
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Zinc	0.029	0.021	0.007	0.023	0.020	0.023	0.017	0.010	0.008	0.005	0.009
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA
Arsenic	0.0013	0.0012	<0.0010	0.0013	0.0013	<0.0010	<0.0010	<0.0010	0.0013	<0.0010	0.0013
Selenium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0020	<0.0020
Cadmium	0.00029	0.00033	0.00015	0.00017	0.00013	<.00010	0.00015	0.00026	0.00020	0.00023	0.00011
Chromium	0.0020	0.0021	0.0026	0.0021	<0.0010	0.0028	0.0021	<0.0010	0.0010	<0.0010	<0.0010
Copper	0.0018	0.0023	0.0026	0.0025	0.0045	0.0021	0.0020	0.0016	0.0016	0.0005	0.0001
Nickel	0.0048	0.0051	0.0039	0.0032	0.0036	0.0048	0.0042	0.0031	0.0033	<0.0038	0.0078
Lead	0.0024	<0.0020	0.0020	0.0027	<0.0020	0.0025	0.0025	0.0021	<0.0020	<0.0020	<0.0020
Sulfate	11	12	7.0	6.1	10	11	6.7	7.3	6.8	NA	NA
Total suspended	9.0	29	18	16	10	31	23	5.0	<4.0	9	10
Total organic carbon	6.4	6.2	12	12	14	12	12	4.3	4.3	4.4	6.5
Nitrate & nitrate	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12
Chloride	3.6	3.6	3.5	3.5	3.1	3.7	3.6	9.2	9.0	5	3.8
Ammonia nitrogen	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.19	<0.05
Total phosphorus	0.019	0.018	0.030	0.030	0.041	0.033	0.034	0.020	0.016	0.022	0.039
Total alkalinity	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.4	8.3
Total solids	NA	NA	NA	NA	NA	NA	NA	NA	NA	73	72

[a] See Figure 3.2 for sample locations.
NA = Not analyzed

Table 3.8 Physicochemical Parameters of Lake Avalyn and Bluegill Pond (LES, 1993a)

	Lake Avalyn (1/20/90)			Lake Avalyn (5/23/90)			Bluegill Pond (1/20/90)			Bluegill Pond (5/23/90)		
Depth (feet*)	Temperature (Celsius)	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	Temperature (Celsius)	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	Temperature (Celsius)	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	Temperature (Celsius)	Conductivity (µmhos/cm)	Oxygen (mg/l)
0	11	19	9.2	25	15	6.5	10.5	28	10.0	22	33	4.8
1	12	19	9.2	25	25	6.35	11	28	9.6	21.5	33	4.6
2	12	19	9.1	25	26	6.1	11	28	9.6	21	36	4.5
3	12	19	9.0	24	26	5.65	10	28	9.4	20	40	0.7
4	12	19	8.9	24	27	4.4	8	28	9.2	20	40	0.6
5	12	19	8.6	24	29	1.6	7	28	8.6	19	45	0.5
6	11	19	8.5	23	30	0.6	7	28	8.6	17.5	51	0.5
7	10	19	8.4	22	30	0.5	7	28	8.8	17	60	0.45
8	10	20	8.4	21	31	0.5	7	28	9.0	15	68	0.4
9	9.5	20	8.5	20	33	0.4	7	28	9.0	15	71	0.4
10	9	20	8.5	19	40	0.4	6.5	28	8.8	14	76	0.4
11	9	20	8.4	18	43	0.4	6.5	28	8.8	13.5	88	0.35
12	9	20	7.5	18	47	0.4	6.5	28	7.6	13.5	94	0.3
13	9	20	6.9	17	48	0.3	–	–	–	–	–	–
14	9	20	6.1	17	52	0.3	–	–	–	–	–	–
15	–	–	–	17	55	0.3	–	–	–	–	–	–
pH		5.31		6.21			NC: Meter malfunction			6.03		
Turbidity		2.3 & 2.8 NTU		2.6 NTU			8.2 & 8.2 NTU			43 NTU		
Alkalinity		2.0 & 3.0 mg/l (CaCO3)		12 mg/l			4.0 & 4.0 mg/l (CaCO3)			9.5 mg/l		
Total hardness		8.4 & 7.6 mg/l (CaCO3)		NC			7.4 & 7.4 mg/l (CaCO3)			NC		
Secchi disk depth		NC		43"			NC			11"		

– = Bottom of lake or pond.
NC = Data not collected.
* To convert to meters: m = ft x 0.3048

Table 3.9 Water Chemistry Data for Lake Avalyn (LES, 1993b)

Date	Temperature (C°)		pH		Specific Conductance (μmhos/cm)		Dissolved Oxygen (mg/l)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
6/91	30	23	2.8	4.3	105	25.0	5.3	0
9/91	31	29	5.3	4.5	16.3	34.5	7.5	0.5
12/91	15	13	5	5.2	41.5	44.4	10.1	7.8
3/92	16	12	4.8	4.6	34.8	34.0	8.4	3.7
6/92	28	27	5.4	4.7	18.7	20.3	5.8	3.1
9/92	28	27	5.4	4.7	18.7	20.3	5.8	3.1
12/92	10	9	4.2	4.3	15.3	17.5	10.2	10.1
3/93	18	13	4.9	4.5	15.8	16.8	10.0	6.0
6/93	28	24	4.9	5.0	20.2	57.0	6.4	1.4

Table 3.10 Water Chemistry Data for Bluegill Pond (LES, 1993b)

Date	Total Hardness (mg/l as $CaCO_3$)	Sulfates mg/l	Total Suspended Solids (mg/l)
12/30/92	7	5	2.6
11/13/93	6	7	4.0
01/27/93	6	6	4.6
02/11/93	5	4	—
02/24/93	6	3	5.0
03/10/93	4	6	4.8
03/24/93	6	4	3.6
04/12/93	6	3	6.2
04/26/93	6	6	16.2
05/10/93	6	4	1.6
05/24/93	5	5	3.8
06/07/93	7	3	1.6
06/22/93	6	3	3.2

in early summer, as evidenced by the low values of dissolved oxygen measurements. These observations are similar to those detected in 1990 (Table 3.7), indicating the occurrence of lake stratification.

Bluegill Pond water is characterized as being soft, with an average total hardness of 6 mg/l as $CaCO_3$. Total suspended solids (TSS) are generally less than those reported in 1990 (Table 3.8). An exception is the measurement taken on April 26, 1993, when TSS reached 16.2 mg/l (LES, 1993b). Sulfates in Bluegill Pond are considerably below the Louisiana water quality standard for the Lake Claiborne region, 15 mg/l.

According to Westinghouse (1989), the Army Corps of Engineers determined that a small area of wetlands exists on the proposed site. This area is located in the northeast corner of the site, downstream of the Lake Avalyn dam. The soils map (Figure 3.6) identifies this area as Iuka-Darley soils, which are subject to frequent flooding (Kilpatrick and Henry, 1989).

Flood hazard boundary maps were developed by the Federal Emergency Management Agency (FEMA) as part of the National Flood Insurance Program. These maps were evaluated to determine if the CEC would be located in or near a floodplain and, therefore, subject to flood hazard. FEMA developed flood hazard boundary maps for all of Claiborne Parish, except for those areas designated as "areas of minimal flood hazard." Because the proposed CEC facility is located in one of these areas, no flood hazard boundary maps could be evaluated for this area. The nearest mapped flood hazard area is located approximately 5.2 km (3.2 miles) to the southeast of the southern boundary of the proposed facility, along the shore of Lake Claiborne. Therefore, it was concluded that the proposed CEC facility would not be located in or near a flood hazard area.

The largest surface water body in the vicinity of the site is Lake Claiborne, which is used extensively for recreational purposes, including swimming, boating, fishing, and water skiing. Although not presently used as a source of public drinking water, the lake could be a potential source of drinking water in the future. The two main streams draining from the site are Cypress Creek to the west and McCasland Creek to the east. Human use of these streams was not documented, although it is likely that children in the area may use these creeks for recreational purposes. In addition, livestock raised by residents living along the downstream reaches of both creeks may use the creeks as sources of water (LES, 1994a). Due to the intermittent nature of these creeks, it is probable that water usage is limited.

3.3.2 Groundwater Resources

The hydrogeology of the proposed CEC site can be described in terms of the regional aquifers found at and in the vicinity of the site, as well as the local shallow aquifer. A list of the hydrogeologic units at the site is given in Table 3.11. The regional aquifers in the vicinity of the proposed site are, from deepest to shallowest, the aquifers in the Wilcox Group, the Carrizo Sand, the Sparta Sand, and the Cockfield Formation. The Wilcox Group and the Carrizo Sand, which are hydraulically connected, are referred to as the Wilcox-Carrizo Aquifer. The Cane River Formation, a clay confining layer, separates the Wilcox-Carrizo Aquifer from the overlying Sparta Aquifer. The Cook Mountain Formation is a predominantly silty clay that acts as an upper confining unit for the Sparta Aquifer. The

Table 3.11 Hydrogeologic Units Identified in the Vicinity of the Proposed CEC Site (LES, 1994a)

Period	Epoch	Group	Formation	Hydrogeologic Unit
Quaternary	Holocene and Pleistocene		Terrace and Alluvial Deposits	Terrace and Alluvial Deposits
			Cockfield Formation	Cockfield Aquifer
			Cook Mountain Formation	Confining Layer
		Claiborne	Sparta Sand	Sparta Sand Aquifer
	Eocene		Cane River Formation	Confining Layer
Tertiary			Carrizo Sand	
		Wilcox	Undivided	Wilcox-Carrizo Aquifer
	Paleocene	Midway	Undivided	Confining Layer[a]

[a] Confining layer below Wilcox-Carrizo aquifer also includes units of Cretaceous age.

Cockfield Aquifer, which lies above the Sparta Aquifer, may contain groundwater under water table conditions. Finally, upland terrace and alluvial deposits that overlie the Cockfield Formation may contain groundwater under water table conditions, but are not a regionally continuous aquifer.

The primary source of water for Claiborne Parish is the Sparta Sand Aquifer (Westinghouse, 1989). The population supplied with drinking water from the Sparta Sand Aquifer is broken down in Table 3.12. Typical well depths in this aquifer generally range from 122 to 198 m (400 to 650 ft) bgs. Pumping rates are reportedly as high as 6,814 liters per minute (1,800 gpm) near West Monroe, Louisiana. The elevation to which water would rise in wells (the potentiometric surface) in the Sparta Sand Aquifer is shown in Figure 3.11. The map indicates that groundwater in the Sparta Sand Aquifer generally flows northeast from the proposed CEC site. Also evident on the map are several major cones of depression created by water supply pumping centers at locations such as El Dorado, Arkansas and Monroe, Louisiana. Snider et al., (1972) reports extensive lowering of the potentiometric surface of the Sparta Sand Aquifer. Table 3.13 presents the hydraulic conductivity of several areas of the Sparta Sand Aquifer. As indicated in Table 3.13, the aquifer has generally high hydraulic conductivity and transmissivity, providing large supplies of groundwater.

Table 3.12 Number of Persons in Claiborne Parish, Louisiana Supplied with Water from the Sparta Sand Aquifer (LES, 1994a)

	Population Served	
Water System[a]	Number of People	Percentage of Total
Athens Water Supply	450	2%
Haynesville Water Supply	6,400	29%
Homer Water Supply	7,275	34%
Lisbon Water Supply	700	3%
South Claiborne Water System	3,000	14%
Pine Hill Water Supply	510	2%
Wade Correctional Center	540	2%
Central Claiborne Water System	1,200	6%
Norton Shop Water System	155	1%
Summerfield Water System	750	3%
Middle Fork Water Supply	480	2%
Rambin-Wallace Water Supply	240	1%
Total for Claiborne Parish	21,700	100%

[a]All of these systems obtain their water supply from groundwater.

In the vicinity of the proposed CEC site, water is obtained from both shallow wells in the Cockfield Formation and deeper wells in the Sparta Sand Aquifer. The locations of wells installed in the Sparta Sand Aquifer nearest the site, and used locally as drinking water sources, are shown in Figure 3.12. Local domestic wells are generally shallow (5.4 to 22 m [18 to 72 ft] bgs) and produce water from discontinuous sand lenses in the Cockfield Formation. LES conducted a door-to-door water use survey within a 3.2 km (2 mile) radius of the site. Forty of the 51 individuals contacted actually responded. Of these, 13 residents indicated they had shallow water supply wells. Eleven of these wells are currently used for household purposes, gardening, and livestock watering. During the NRC scoping meeting on July 30, 1991, in Homer, a local resident indicated that at least 40 private water wells within 5 miles of the site were in use for domestic purposes.

A preliminary survey of the site (Westinghouse, 1989 and LES, 1993b) revealed that at least three open water wells exist on the site: two near Lake Avalyn and one in the southeastern corner of the site. However, no information was available on the date of installation or depth of these wells. Samples taken from one of the abandoned wells located within 0.5 km (.3 miles) of the gas well near the southwest corner of the site showed no presence of contaminants (LES, 1994a).

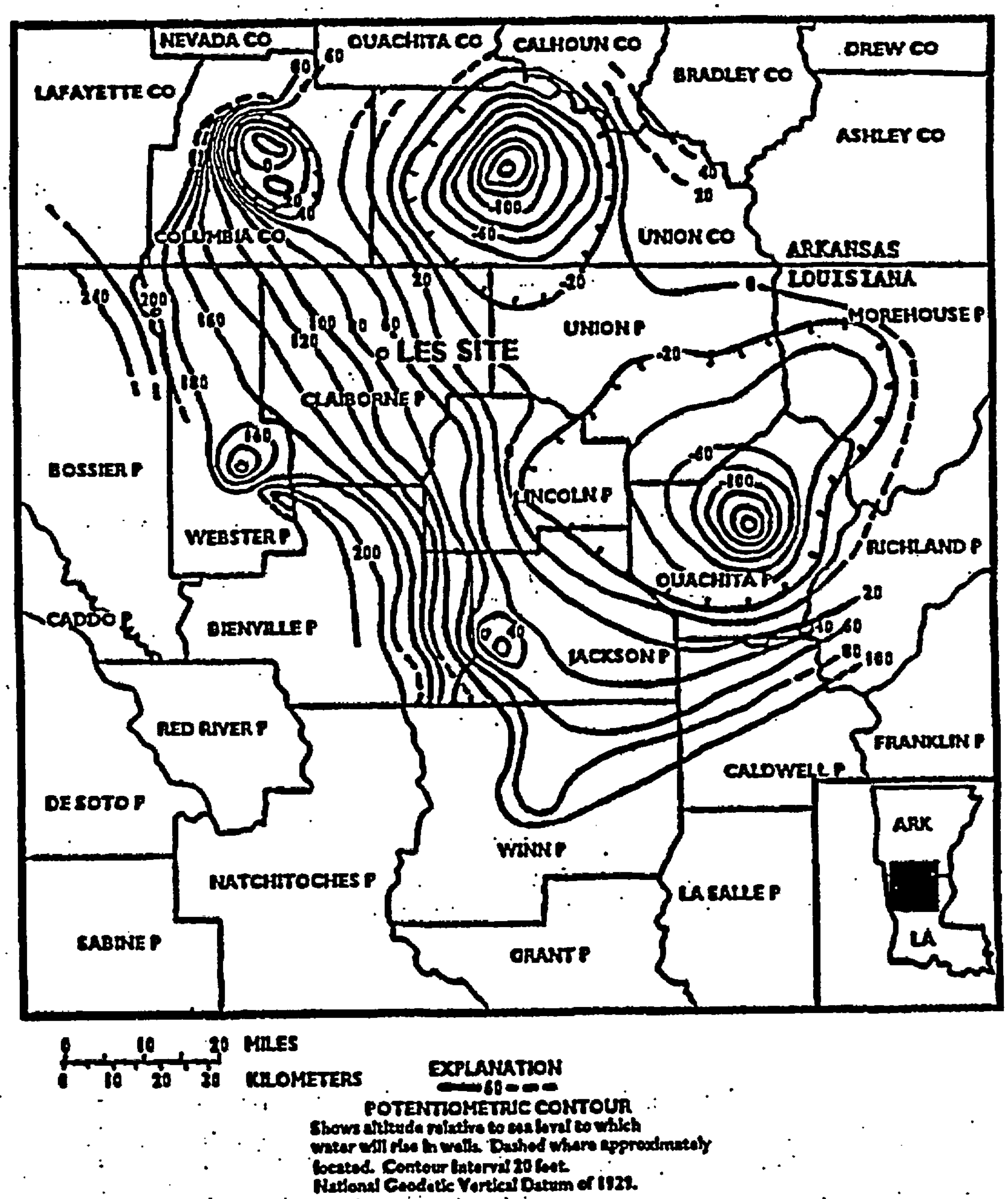

Figure 3.11 Map of Potentiometric Surface of the Sparta Sand Aquifer (Ryals, 1984)

Table 3.13 Hydraulic Parameters of the Sparta Sand Aquifer as Reported by Various Sources

Hydraulic Conductivity

Value[a] gpd/ft²	Value[b] ft/day	Source	Area Considered
Range 200 - 780 Average: 400	Range 27 - 105 Average: 50	Snider et al. (1972)	Union Parish
220 ->750	30 - >100	Ryals (1982)	Vicinity of site
450 - 500	60 - 67	Payne (1968)	Vicinity of site
350 - 780	47 - 105	Well Logs	Within 7.2 km of site

[a] To convert to meters per second: m/s = gpd/ft² x (4.72×10^{-7})
[b] To convert to meters per day: m/d = ft/d x (3.048×10^{-1})

Transmissivity

Value[a] gpd/ft²	Value[b] ft/day	Source	Area Considered
7,000 - 83,000	940 - 11,000	Snider et al. (1972)	West Monroe
100,000 - 150,000	13,000 - 20,000	Payne (1968)	Vicinity of site
15,000 - 29,800	2,000 - 4,000	Nelson & Herbert (1986)	Vicinity of site
41,000 - 45,000	5,500 - 6,030	Well Logs	Within 7.2 km of site

[a] To convert to cubic meters per second: m^2/s = gpd/ft x (1.438×10^{-7})
[b] To convert to cubic meters per day: m^2/d = ft^2/d x (9.290×10^{-2})

Detailed information about shallow groundwater characteristics at the site was gained from soil borings and well installation during three site hydrogeologic investigations (Figure 3.13) (Westinghouse, 1989; Law Engineering, 1990b; and LES, 1993b). The first set of borings was performed in July and August of 1989, ranging in depth from 13 to 23 m (43.5 to 75 ft) (Westinghouse, 1989). These borings were performed to obtain data that could be used to characterize the suitability of soils to support loads, suitability of onsite soils for use as structural fill, and general surface and subsurface conditions that may impact construction. A second set of borings was performed in March and April of 1990 (Law Engineering,

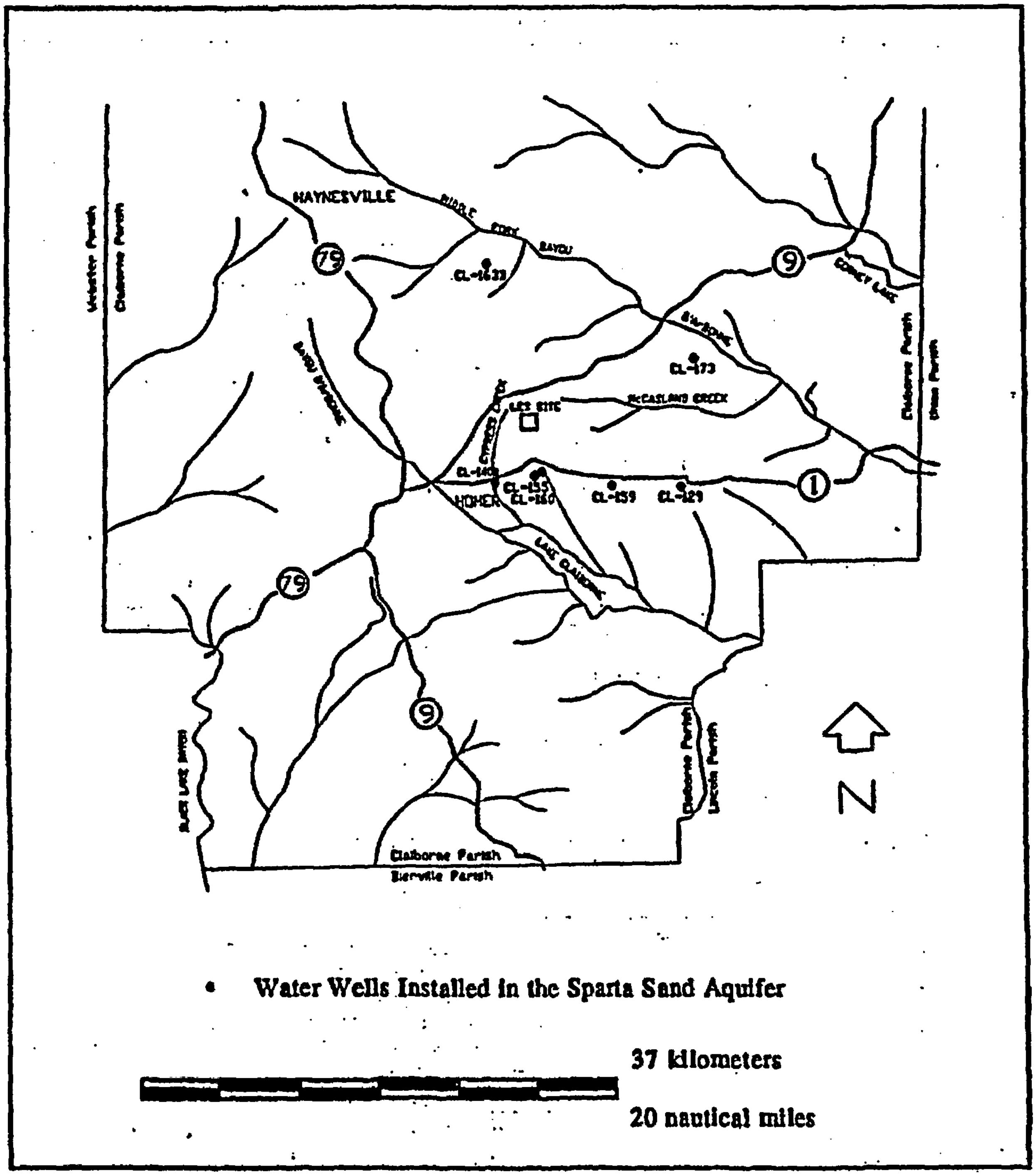

Figure 3.12 Location of Water Supply Wells Installed in the Sparta Sand Aquifer in the Vicinity of the CEC Site (LES, 1994a)

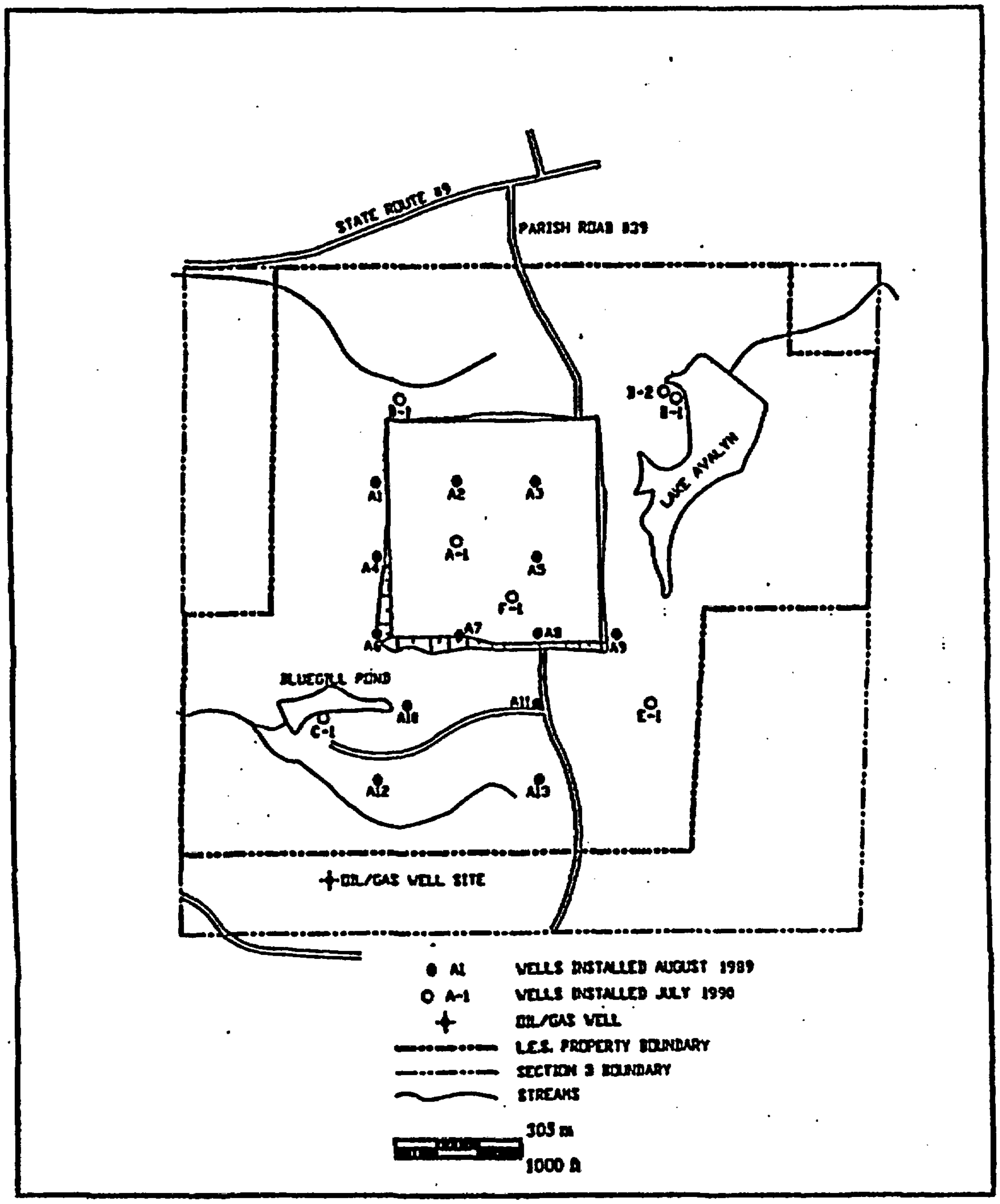

Figure 3.13 Locations of Soil Borings and Groundwater Monitoring Wells at the Proposed CEC Site (LES, 1994a)

1990b). These borings ranged in depth from 7.6 to 30 m (25 to 100 ft) and were used to determine the following subsurface characteristics:

- static and seismic load-bearing capacity;
- suitability of excavated soils for fill; and
- nature of geologic formations underlying the site.

Temporary piezometers were installed in four borings at representative locations across the site to determine the groundwater elevation.

An additional seven monitoring wells were installed at the site during the last week of July 1990, to collect and analyze aquifer material and groundwater samples (LES, 1994a). The wells were screened in the first encountered saturated zone. Geologic samples were analyzed for density, porosity, moisture content, and total organic carbon. Groundwater samples were analyzed for physical parameters and inorganic chemicals.

Figures 3.14 and 3.15 illustrate groundwater contours at the site, based on groundwater elevation measurements taken in April 1990 and August 1990, respectively. As seen in these figures, the shallow groundwater follows the local topography and discharges to local surface water bodies. As illustrated in Figure 3.15, the center of the site, where the facility will be located, is a drainage divide and recharge area for local shallow groundwater which flows to the northeast and southwest from the divide. Perched water conditions (locally elevated water tables resulting from impermeable clay lenses) were encountered in 9 of 13 test pits at depths of 1.8 to 3.0 m (6 to 10 ft) (Law Engineering, 1990b). Discharge from these areas to groundwater seeps, which is evident in hillsides on the site, also occurs vertically downward into the saturated zone.

Average linear velocities (V) of groundwater between onsite monitoring wells installed in the shallow aquifer were computed using Darcy's Law:

$$V = \frac{K}{N}\left(\frac{dh}{dl}\right)$$

where:

V=average linear groundwater velocity (ft/day)
K=hydraulic conductivity (ft/day)
N=porosity (%)
dh/dl = hydraulic gradient (ft/ft) (i.e., the elevation difference in the water table between two points over a distance)

The average linear velocities (i.e., groundwater flow rates) were computed using averages of measured values of hydraulic conductivity and porosity in each well and are provided in Table 3.14. Flow rates were computed assuming that the two wells in the first column of the table are hydraulically connected. While this assumption may not be accurate for all

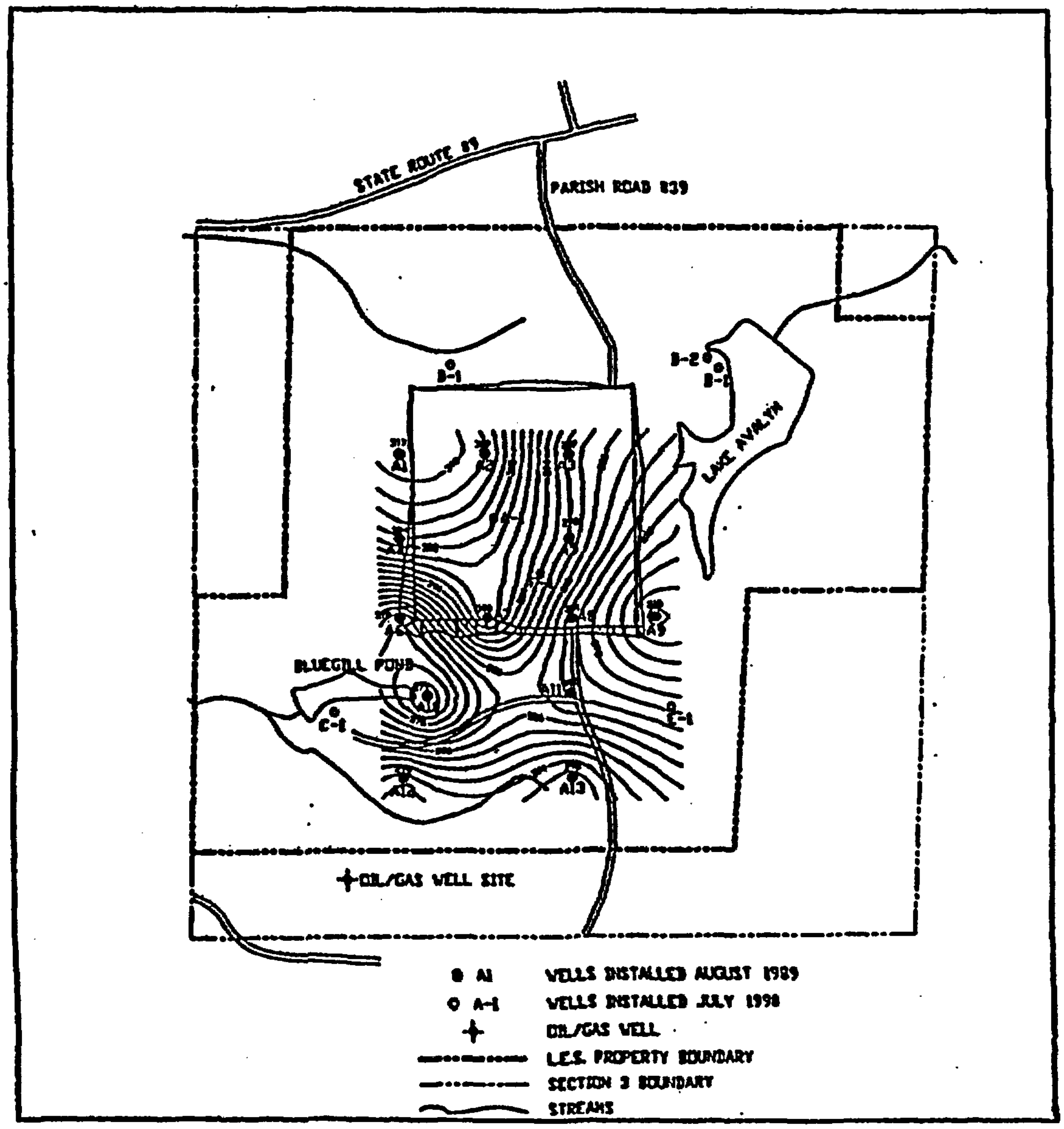

Figure 3.14 Shallow Groundwater Contours at the Proposed CEC Site Based on Groundwater Elevation Measurements Taken in April 1990 (Law Engineering, 1990b)

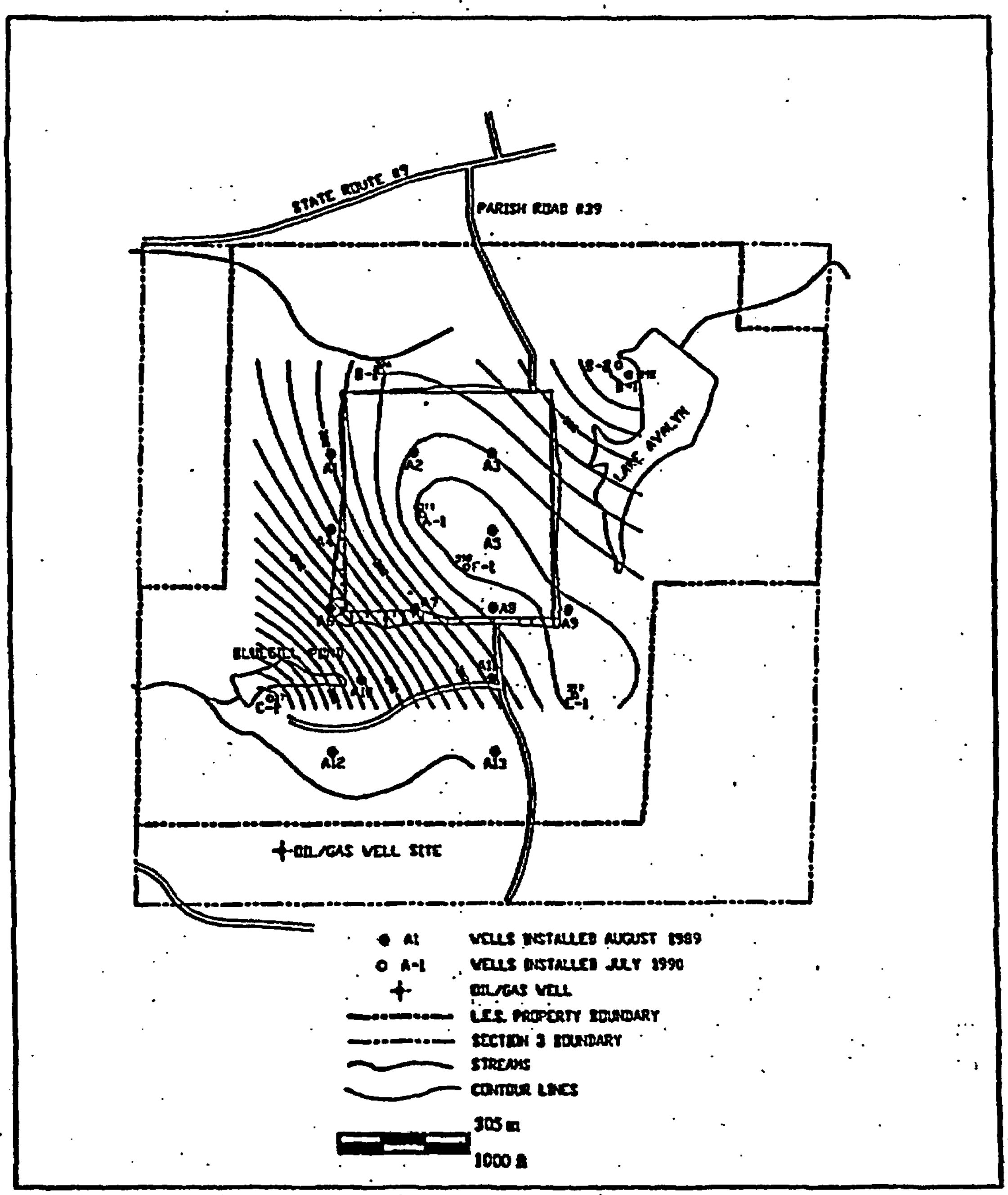

Figure 3.15 Shallow Groundwater Contours at the Proposed CEC Site Based on Round II Groundwater Elevation Measurements Taken in August 1990 (Law Engineering, 1990b)

Table 3.14 Parameter Values Used to Compute Groundwater Velocities in the Shallow Aquifer Beneath the Proposed CEC Site (LES, 1994a)

Wells	Average Hydraulic Conductivity, KK (ft/day)	Average Porosity, N (%)	Difference in Water Table Elevation, dh (ft)*	Distance Between Wells dl (ft)*	Average Linear Velocity V (ft*/yr)	Flow Time Between Wells (years)
A1-B1	0.4	40.2%	15.98	1950	3.0	655
F1-B1	1.75	42.8%	15.15	2000	11.3	177
E1-B1	0.5	45.0%	16.05	2600	2.5	1037
A1-D1	0.4	37.3%	5.27	1050	1.8	573
A1-C1	0.154	37.5%	40.73	1800	3.4	531
E1-C1	0.254	42.3%	40.8	2250	4.0	565
F1-C1	1.504	40.1%	39.9	1685	32.4	52

* *To convert to meters: m = ft x 0.305*

of the pairs of wells, it provides a method of determining a range of average groundwater flow rates in the shallow aquifer. These flow rates were used to estimate potential travel times for groundwater to migrate from the proposed CEC to both Bluegill Pond and Lake Avalyn. As shown in Table 3.14, groundwater flows most rapidly from the center of the site to the southwest and northeast. For example, estimates indicate that it would take 52 years for groundwater to flow from the site to Bluegill Pond (i.e., between wells F1 and C1), and 177 years for groundwater to flow northeast from the site to Lake Avalyn (i.e., between wells F1 and B1). On the other hand, the slowest groundwater flow would most likely be from the center of the site to the northwest or southeast along the topographic high running through the center of the site.

Results of chemical analyses of shallow groundwater at the site are provided in Table 3.15. Background levels of metals in unfiltered samples are below regulatory limits: beryllium (up to 0.010 mg/l), arsenic (up to 36 mg/l), cadmium (up to 1.4 mg/l), chromium (up to 94 mg/l), copper (up to 62 mg/l), lead (up to 45 mg/l), nickel (up to 96 mg/l), and zinc (0.7 mg/l). Unfiltered samples indicate the presence of zinc (0.006 to 0.011 mg/l), cadmium (0.44 to 1.1 mg/l), and copper (3.0 to 17 mg/l). Sulfate concentrations ranged from 5.3 to 83 mg/l. The 83 mg/l concentration exceeds the current State of Louisiana numerical water quality criteria of 15 mg/l for the Lake Claiborne Region. The Louisiana Office of Water Resources has indicated that the sulfate discharge concentration will be limited to 250 mg/l (LDEQ, 1994). Additional samples of the Sparta Aquifer (LES, 1993b) were taken at the request of the LDEQ and are provided in Table 3.16. These results showed that sulfate measurements were consistently above the 15 mg/l, but below 250 mg/l.

Table 3.15 Chemical Data from Unfiltered Samples Collected from Onsite Groundwater Monitoring Wells (mg/l) (LES, 1993a)

	Sampling Location[a]						
Sample Identification	Well A-1	Well B-1	Well B-2	Well C-1	Well D-1	Well E-1	Well F-1
Total Alkalinity	5.9	4.5	71	62	42	1.5	1.7
Mercury in Water	0.3	<0.1	0.18	1.1	<0.1	0.23	<0.1
Total solids	3786	1299	2330	1376	288	2009	349
Total suspended solids	3317	163	3690	980	116	1136	259
Total organic carbon	2.3	2.5	4.0	3.5	1.1	1.2	1.4
Nitrite & nitrite	0.64	1.0	0.09	0.11	<0.05	0.47	0.34
Chloride	4.8	8.0	7.0	4.3	4.6	4.6	4.5
Calcium	2.3	2.2	18	24	12	0.40	0.95
Magnesium	0.60	2.7	6.6	7.7	6.0	0.41	0.83
Sodium	4.4	3.3	9.7	16	6.7	2.2	2.9
Sulfate	7.0	5.8	59	83	52	7.3	15
Hardness (CaCO3)	5.7	16.6	72.1	91.6	29.9	1.7	5.9
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	<0.040	<0.040	<0.40	<0.40	<0.40	0.055	<0.040
Beryllium	0.003	0.001	0.004	0.001	<0.001	0.010	<0.001
Antimony	0.7	<0.4	1.6	<0.4	<0.4	1.4	<0.4
Zinc	0.067	0.70	0.55	0.087	0.039	0.52	0.015
Arsenic	2.1	5.4	36	6.4	2.9	9.5	1.3
Selenium	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cadmium	0.73	0.59	0.82	1.4	0.21	1.2	0.67
Chromium	53	34	71	11	2.5	94	8.8
Copper	26	17	17	8.9	1.1	62	2.4
Nickel	<15	31	96	29	<6.0	73	5.0
Lead	24	26	31	11	2.2	45	3.6

[a] *Well locations are shown in Figure 3.13*

Table 3.16 Sulfate Concentrations and Hardness of the Groundwater in the Sparta Sand Aquifer (LES, 1993b)

Sampling Date	Sulfates (mg/l)	Hardness (mg/l as $CaCO_3$)
12/30/92	23	5
01/13/93	22	3
01/27/93	22	4
02/11/93	21	6
02/24/93	22	7
03/10/93	20	3
03/24/93	21	3
04/12/93	20	4
04/26/93	21	6
05/10/93	21	5
05/24/93	22	4
06/07/93	23	5
06/22/93	25	3
Average	22	4.5

3.4 Climatology and Meteorology

3.4.1 Climatology

The climate of north-central Louisiana is transitional between the subtropical humid climate of the Gulf and the continental climates of the Great Plains and the Midwest. The rural terrain is characterized by gently rolling hills allowing unobstructed air flow to the site from any direction. During winter, masses of moderately cold air move periodically through the area, causing ice storms and freezing rain. Snowfall and prolonged cold spells are unusual, and annual measurable snowfall is rare. Annual rainfall totals over 127 cm (50 in) and occurs primarily as moderate to heavy rains usually associated with thunderstorms, especially in spring and summer; October is the only month that averages less than 8 cm (3 inches) of rainfall. Summer months are quite warm and humid, with afternoon temperatures above 30° C (90° F) and afternoon humidity in the 60 to 75 percent range. The average annual temperature is 18.6° C (65.4° F).

Hurricanes dissipate over southern Louisiana and do not pose a severe wind damage threat to the area. The hurricane winds are usually not destructive, but flooding can be expected near the site. When Hurricane Andrew struck the area on August 26, 1992, winds were reported to be near 59 m/sec (115 knots) at landfall. About 3 1/2 hours later, winds had died to 41 m/sec (80 knots), and the hurricane was downgraded to a tropical storm after

9.5 hours with winds of 26 m/sec (50 knots). The storm downgraded to a tropical depression after 21.5 hours, as winds calmed to 30 knots (15 m/sec or 34 mph) (NHC, 1992). The distance traveled by Hurricane Andrew at the time it was downgraded to a tropical depression is approximately the same distance that would be covered if the storm traveled directly to Homer. A wind speed of 15 m/sec would not be sustained because the force of the storm would be expended near the coast and additional energy would not be available while the storm was moving over land.

Limited climatological data for the site are gathered in Homer; more complete data are gathered at Shreveport, which is the closest National Weather Service (NWS) station. Temperature and precipitation information for Homer is shown in Table 3.17; additional climatic data from Shreveport are shown in Table 3.18. Data for pan evaporation and wind movement gathered at the Red River Research Station, Louisiana, and Calhoun Research Station, Louisiana, are shown in Table 3.19. These sites, located 72 km (45 miles) southwest and 89 km (55 miles) east southeast (ESE) of Homer, respectively, are shown in Figure 3.16. The average soil temperatures for these two sites and for Monroe, Louisiana, located 121 km (75 miles) ESE of Homer, are shown in Table 3.19.

3.4.2 Winds and Severe Storms

Thunderstorms are common in the vicinity of the site, occurring during all months of the year. Shreveport data show that an average of 55.9 thunderstorms occur each year, with the summer months having a higher frequency (Table 3.20). Severe storms causing snow accumulation of 2.5 cm (1 in) or more are infrequent, occurring 0.6 times per year from November to March; over half occur in January. Although the storms are infrequent and the snow or ice rarely remains on the ground more than a few days, the impact to the area is much more severe than in most of the continental United States due to lack of equipment and experience to deal with such conditions. The heaviest rains in this area of Louisiana are associated with very slow-moving tropical depressions. Hurricanes may have heavy rains associated with them in coastal locations (for example, Hurricane Andrew rained approximately 25 cm (10 in) on a near-coastal Mississippi town), but usually degrade into fast-moving tropical depressions. Inland areas rarely get more than a couple of inches during one rainfall.

High winds are most frequently associated with thunderstorms. Hurricanes can cause high sustained winds, but these are rarely of destructive force. Tornados are not particularly common, they are constrained by the forest cover, large amounts of water in rivers and lakes (which moderate extreme temperatures), and rolling hills around the site. The probability of both high straight wind and tornadic winds striking the site was estimated following the guidance in NUREG/CR 3058 (NRC, 1983). The area-intensity relationship of a tornado was developed based on tornados occurring in an area between 30° N. and 35° N. latitude and between 91° and 96° W. longitude (Figure 3.17). The area-intensity relationship is a function of the areal extent of the mean damage path versus wind velocity. An occurrence-intensity relationship was developed based upon the 632 tornados that occurred in an area

Table 3.17 Temperature and Precipitation Information for Homer, Louisiana (Based Upon Data for 1951 - 1980; NOAA, 1984a)

MONTH	TEMPERATURE (°F)[a]							PRECIPITATION (inches)[b]								
								RAINFALL					SNOW		
	AVERAGE HIGH	AVERAGE LOW	MONTHLY AVERAGE	MAX HIGH	MIN LOW	DAYS MAX > 90	DAYS MIN < 32	AVERAGE MONTHLY	GREATEST MONTHLY	MAX DAY	5 % CHANCE > THAN	5 % CHANCE < THAN	AVERAGE	MAX	NO. OF DAYS > 0.1 IN. OF PRECIPITATION
JAN	55.7	34.0	44.9	81	-1	0	15	4.55	13.42	4.44	10.80	1.07	0.8	3.6	7
FEB	60.1	36.6	48.4	81	2	0	11	4.17	8.36	3.55	8.54	1.22	0.5	4.0	6
MAR	67.6	43.4	55.5	87	17	0	5	4.69	10.91	3.39	9.07	1.61	0.2	4.0	7
APR	76.3	52.3	64.4	91	28	0	0	4.92	12.80	4.81	10.94	1.33	0.0	0.0	6
MAY	82.9	59.8	71.4	98	39	3	0	5.06	10.07	4.34	10.48	1.43	0.0	0.0	6
JUN	89.5	66.7	78.1	101	47	17	0	3.92	12.16	5.42	9.73	0.57	0.0	0.0	5
JUL	92.7	70.1	81.4	105	53	25	0	4.60	9.44	4.87	10.36	0.99	0.0	0.0	6
AUG	92.7	68.8	80.8	107	51	24	0	2.85	5.01	2.93	5.39	1.05	0.0	0.0	4
SEP	87.1	63.6	75.4	103	36	13	0	3.53	11.10	4.73	8.21	0.45	0.0	0.0	5
OCT	78.3	51.5	64.9	100	29	2	0	2.94	8.06	4.11	7.62	0.20	0.0	0.0	3
NOV	66.7	42.4	54.6	88	15	0	6	4.16	10.44	5.27	8.13	1.39	0.0	1.0	6
DEC	58.4	36.1	47.3	82	8	0	12	4.36	10.69	3.60	9.06	1.22	0.2	3.0	6
YEAR	75.7	52.1	63.9	107	-1	84	49	49.80	13.42	5.42			1.7	3.6	67

[a] To convert to celcius temperature: (°C) = (°F-32)/1.8
[b] To convert to centimeters: cm = in x 2.54

Table 3.18 Shreveport Climatological Data (NOAA, 1990)

MONTH	% RELATIVE HUMIDITY				DAY TIME SKY COVER %	% POSSIBLE SUNSHINE	HEAVY FOG (VISIBILITY < 0.4 km) (No. of Days)
	MIDNIGHT	06:00	12:00	18:00			
JAN	77	83	63	65	67	50	3.5
FEB	76	83	59	58	63	55	2.2
MAR.	75	83	56	54	63	58	1.4
APR	79	87	56	56	62	59	1.2
MAY	83	90	59	60	60	64	0.8
JUN	84	90	58	59	54	71	0.5
JUL	83	90	57	58	53	74	0.3
AUG	82	91	55	57	51	73	0.5
SEP	82	91	57	61	51	69	1.1
OCT	81	89	54	62	48	69	2.3
NOV	80	86	58	66	55	58	2.7
DEC	79	85	62	67	61	53	2.9
YEAR	80	87	58	60	57	63	19.4

Table 3.19 Regional Evaporation, Wind Movement, and Soil Temperatures (NOAA, 1990)

MONTH	EVAPORATION[a]		WIND MOVEMENT[b]		AVERAGE SOIL TEMPERATURE (°F)[c]					
	RED RIVER	CALHOUN	RED RIVER	CALHOUN	RED RIVER[d]		CALHOUN[e]		MONROE[f]	
					MAX	MIN	MAX	MIN	MAX	MIN
JAN	1.43	-	909	1259	59.6	53.4	60.8	53.5	54.8	44.5
FEB	-	-	1085	-	58.9	52.7	59.3	53.3	52.3	42.3
MAR	3.61	-	1582	1656	65.4	56.3	66.0	55.9	61.4	48.2
APR	5.97	-	1158	1538	76.7	65.0	79.4	63.5	75.7	56.6
MAY	6.66	6.29	1163	1421	-	-	83.7	70.9	80.7	65.4
JUN	5.97	7.20	826	921	87.3	78.3	87.9	77.0	88.0	72.0
JUL	6.58	6.62	609	721	90.0	80.5	91.5	79.6	88.4	75.2
AUG	6.59	6.65	461	704	95.2	84.0	97.2	81.9	96.0	78.3
SEP	5.23	6.67	290	1035	89.8	78.5	90.8	77.4	87.8	71.5
OCT	4.72	5.71	685	1027	80.7	69.4	81.6	67.9	77.6	60.0
NOV	3.11	4.60	955	1429	69.3	60.9	70.1	60.2	65.0	50.5
DEC	-	3.61	-	-	54.9	49.6	54.7	49.6	45.4	35.3
YEAR	-	-	-	-	-	-	76.9	65.9	72.8	58.3

[a] 1 inch = 2.54 cm
[b] In miles, it is product of wind speed and duration at each speed independent of direction. (1 mile = 1.6 km)
[c] To convert to celcius temperature: °C = (°F - 32)/1.8
[d] Bare Red River Alluvium at 0% slope.
[e] Bare Ruston fine sandy loam at 0% slope.
[f] Bare Sharkey Clay at 0% slope.

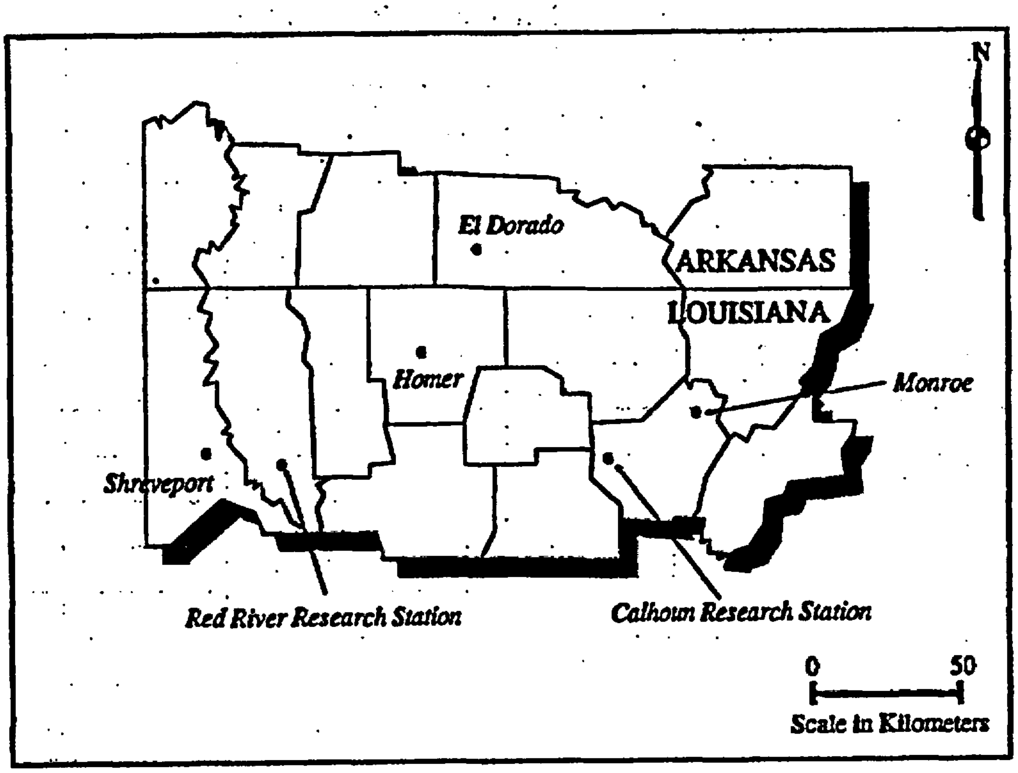

Figure 3.16 Locations of Major Meteorological Sites Near CEC

bounded between 92° and 95° W. longitude and between 31° and 34° N. latitude (36,000 square miles) from 1950 to 1987. This is equivalent to 16.6 tornados per year in an area the size of Indiana. There is no significant statistical difference in frequency of tornados between the area bounded between 92° and 95° W. longitude and between 31° and 34° N. latitude and the area bounded between 92° and 94° W. longitude and between 32° and 34° N. latitude (McDonald-Mehta Engineers, 1990).

Straight wind speed was based upon maximum annual wind speed data obtained from both Shreveport and the Barksdale Air Force Base. Data were corrected to a standard meteorological tower height of 10 m and then converted to fastest-mile wind speed. The fastest-mile wind speed probabilities from this data (Table 3.21) were combined with the tornado data (Table 3.22) to obtain an overall wind speed probability data set. Meteorological tower heights at both locations were about 6 m (20 ft), as opposed to the standard height of 10 m. As a result, the reported wind speeds are lower than obtained at a standard tower height due to friction with the ground, vegetation, and structures.

Table 3.20 Characteristics of Wind and Frequency of Thunderstorms at Shreveport, Louisiana (NOAA, 1990)

MONTH	SHREVEPORT WIND					THUNDER-STORMS	SNOW OR ICE GREATER THAN 2.54 CM
	MEAN SPEED (MPH)[a]	PREVAILING DIRECTION[b]	HIGHEST 1 MIN SPEED (MPH)[a]	DIRECTION (DEGREES)	PEAK GUST (MPH)[a]		
JAN	9.3	S	37	220	41	1.8	.3
FEB	9.7	S	40	270	49	2.7	.2
MAR	10.2	S	41	290	58	4.9	.1
APR	9.8	S	52	280	63	5.6	0.0
MAY	8.4	S	39	280	52	7.1	0
JUN	7.5	S	37	160	55	7.2	0
JUL	7.1	S	46	290	66	8.0	0
AUG	6.9	S	37	250	49	6.6	0
SEP	7.3	ENE	44	190	38	4.0	0
OCT	7.4	SSE	35	310	41	2.7	0
NOV	8.6	S	38	290	47	3.0	0.[c]
DEC	9.0	S	37	140	64	2.2	0.1
YEAR	8.4	S	52	280	66	55.9	0.6

[a] To convert to meters per second: m/sec = mph x 0.447
[b] Through 1963
[c] The value is between 0.1 and 0.05

Table 3.21 Fastest-Mile Wind Speed Probabilities (McDonald-Mehta Engineers, 1990)

Annual Probability	Wind Speed[a] (m/sec)	Type of Wind
1:10	23	Straight
1:100	27	Straight
1:1,000	32	Straight
1:3,000	34	Straight, Tornado
1:10,000	51	Tornado
1:100,000	78	Tornado
1:1,000,000	100	Tornado

[a] Represents a 2-second gust.

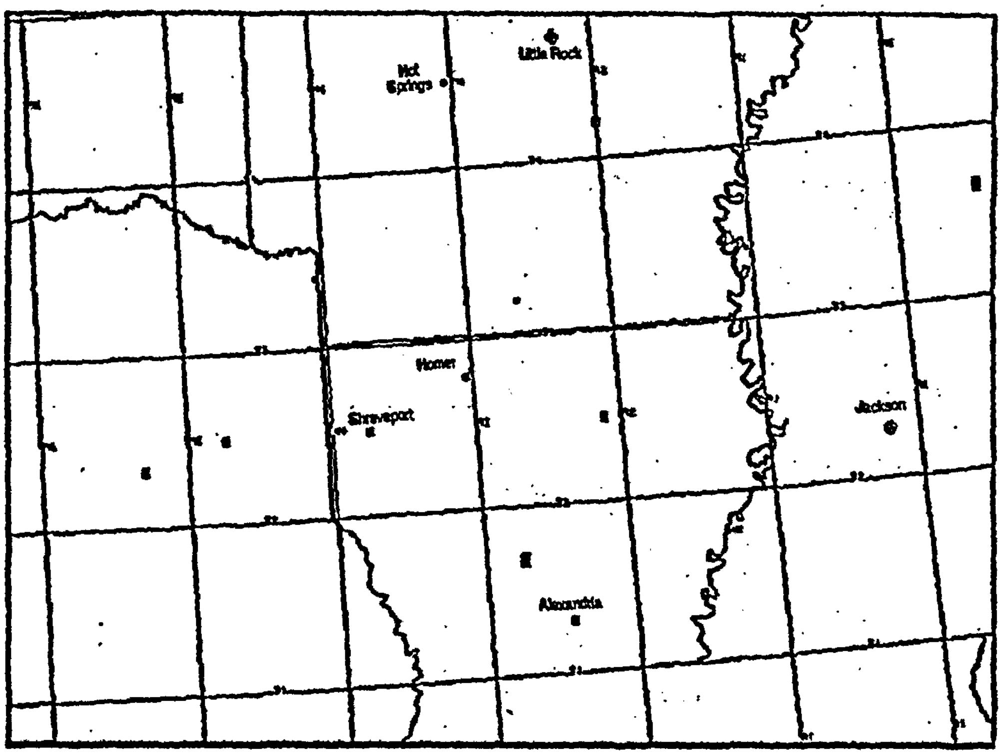

Figure 3.17 Area Evaluated in Developing Area-Intensity Relationship of Tornado

Table 3.22 Frequency of Damaging Tornados (McDonald-Mehta Engineers, 1990)

F-Scale	Number of Tornados [a]	Mean Area Damaged [b] hectares(acres)	Median Wind Speed (m/sec) [c]
F0: Light damage - wind speeds 40-72 mph. Some damage to chimneys and TV antennas occurs; branches broken off trees; old trees with hollow insides break and fall.	108	4.6 (11.5)	25
F1: Moderate damage - 73-112 mph. Beginning of hurricane speeds. Surface of roofs peeled off; windows broken; trailer houses are pushed or turned over; trees on soft ground are pushed over; some trees snapped.	256	56.2 (139)	41
F2: Considerable damage - 113-157 mph. Roofs torn off frame houses, leaving strong walls upright; weak structures and outbuildings destroyed; trailer homes are demolished; cars blown off highway.	184	216 (535)	60
F3: Severe damage - 158-206 mph. Some rural buildings completely demolished; roofs and some walls torn off well-constructed buildings; trains overturned; cars lifted off the ground and rolled; most trees uprooted or snapped; block structures often leveled.	74	531.7 (1316)	81
F4: Devastating damage - 207-260 mph. Well-constructed houses leveled; structures with weak foundations lifted, torn, and blown away some distance; trees debarked by flying debris; gravel and sand fly in wind; cars blown, rolled, and destroyed; large missiles generated.	9	1256.4 (3110)	104
F5: Incredible damage - 261-318 mph. Strong-framed houses lifted and carried considerable distance to disintegrate; steel reinforced concrete structures badly damaged; automobiles fly 100 yards or more.	1	2651 (6562)	129

[a] Reported tornados in 1950-1987 period within latitude 31 - 34° N. latitude and 92 - 95° W. longitude.

[b] Mean area of damage due to tornados from 1970 to 1987 within 30 - 35° N. latitude and 91 - 96° W. longitude.

3.4.3 Meteorology and Dispersion

The meteorological factors affecting dispersion and, consequently, the ambient air quality are related to wind speed, atmospheric stability, and mixing heights. There are no meteorological stations in the immediate vicinity of the site, however, three sites are reasonably close and suitable for use in terms of meteorology. These sites are Shreveport, Louisiana, which is approximately 72 km (45 miles) west southwest (WSW) of the site; Monroe, Louisiana, which is approximately 92 km (57 miles) east southeast (ESE) of the site; and El Dorado, Arkansas, which is approximately 56 km (35 miles) northeast (NE) of the site (Figure 3.16). Temperature and precipitation data measured from these three sites are provided in Table 3.23 and Table 3.24, respectively. These data show the regional trend of increasing temperature and precipitation from north to south and from west to east. The differences between the data for these stations and the Homer station are negligible, demonstrating similar climates for all four sites.

The frequency that wind blows in a particular direction or at various speeds is usually represented graphically with a "wind rose." Wind roses for the three sites and a nighttime wind rose for Shreveport are provided in Figures 3.18 through 3.21. The wind roses for all three sites are very similar[1], but the wind at the El Dorado site is less stable than the wind at either Shreveport or Monroe, which have virtually identical stability classifications. Both Shreveport and the proposed CEC site are located on high hills. There are no intervening geologic features or large bodies of water capable of affecting the weather between the two sites. El Dorado's meteorological data should be excluded from consideration because both the city and the meteorological station are located in a valley, typical of southern Arkansas.

The valley temperatures are often lower than temperatures in surrounding areas due to shade during daylight hours and radiational cooling at night. This creates inversion layers at different altitudes than the predominant mixing layer. Because the Shreveport station is closer to the proposed site, it is most appropriate to use meteorological data from this station (Ethridge, 1992).

The wind speed and direction were measured at heights lower than the standard 30 m (98 ft) at all of the sites; many of the stations experienced interference from buildings. Thus, the wind speeds reported were lower than would be reported by a standard meteorological tower. Other effects of the lower heights include increased frequency of reported calms and fewer shifts in wind direction.

Shreveport's meteorological station location description was as good or better than any other site. In August 1988, a standard meteorological tower was put into service. A wind rose for 1989 (Figure 3.22) shows fewer calm periods (7.61 percent versus 12.92 percent) and higher wind speeds, as expected.

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[1] *Note that the wind roses are for 5 years of surface wind data. EPA has shown that there is little statistical difference in 5 years of data, and even though the years of record are different for these sites, it should not be considered that the conclusions drawn are suspect.*

Table 3.23 Regional Temperatures in Degrees Fahrenheit[a] (NOAA, 1990)

MONTH	SHREVEPORT, LA					EL DORADO, AR					MONROE, LA				
	AVERAGE HIGH	AVERAGE LOW	MONTHLY AVERAGE	MAX HIGH	MIN LOW	AVERAGE HIGH	AVERAGE LOW	MONTHLY AVERAGE	MAX HIGH	MIN LOW	AVERAGE HIGH	AVERAGE LOW	MONTHLY AVERAGE	MAX HIGH	MIN LOW
JAN	55.8	36.2	46.0	84	3	53.7	32.4	43.1	82	-10	54.9	35.6	45.3	82	-1
FEB	60.6	39.0	49.8	89	12	58.6	34.9	46.8	88	-9	59.8	38.7	49.3	86	-2
MAR	68.1	45.8	57.0	92	20	66.5	42.4	54.5	91	16	67.3	45.4	56.4	91	19
APR	76.7	54.6	65.7	94	31	75.8	51.5	63.7	95	27	76.6	54.3	65.4	92	33
MAY	83.5	62.4	73.0	95	42	82.6	59.7	71.2	97	36	83.9	62.5	73.2	99	43
JUN	90.1	69.4	79.8	101	52	89.4	67.1	78.3	103	46	90.7	69.2	80.0	104	52
JUL	93.3	72.5	82.9	106	58	92.6	70.8	81.8	107	54	92.7	72.1	82.4	105	54
AUG	93.2	71.5	82.4	107	54	92.0	69.4	80.7	106	50	92.0	70.3	81.2	105	51
SEP	87.7	66.5	77.1	103	42	86.4	63.7	75.1	106	35	87.0	64.7	75.9	104	35
OCT	78.9	54.5	66.7	97	29	77.1	50.7	63.9	97	26	78.7	51.5	65.1	98	29
NOV	66.8	44.5	55.7	88	16	64.9	40.5	52.7	88	15	66.5	42.6	54.6	90	19
DEC	59.2	38.2	48.7	84	5	57.1	34.6	45.9	82	-4	58.5	37.4	48.0	81	8
YEAR	76.2	54.6	65.4	107	3	74.1	51.5	63.1	107	-10	75.7	53.7	64.7	105	-2

[a] To convert to celcius temperature: °C = (°F - 32)/1.8

Table 3.24 Means of Regional Precipitation in Inches* [[a]NOAA, 1990; [b]NOAA, 1984(b); [c]NOAA, 1984(c)] Based on 1951-1980 Averages

MONTH	Shreveport[a], LA					El Dorado[b], AR					Monroe[c], LA				
	MEAN	MAX.	SNOW MEAN	SNOW MAX.	DAYS > 0.01"	MEAN	MAX.	SNOW MEAN	SNOW MAX.	DAYS > 0.1"	MEAN	MAX.	SNOW MEAN	SNOW MAX	DAYS > 0.1"
JAN	4.02	10.09	0.9	5.9	9.2	4.74	9.65	1.4	11.9	7	4.84	11.94	0.6	4.6	7
FEB	3.46	8.57	0.5	4.4	8.1	4.02	9.00	0.4	6.0	6	4.41	11.04	0.5	8.7	6
MAR	3.77	7.23	0.2	4.0	9.2	4.83	9.42	0.4	5.0	7	5.21	12.50	0.1	3.0	7
APR	4.71	11.19	T	0.3	8.6	5.37	19.56	0.0	0.0	6	4.95	10.05	0.0	0.0	6
MAY	4.70	11.78	T	T	8.8	4.79	9.57	0.0	0.0	7	5.04	10.59	0.0	0.0	6
JUN	3.54	17.11	0.0	0.0	7.9	3.62	15.04	0.0	0.0	5	3.30	6.63	0.0	0.0	5
JUL	3.56	9.46	0.0	0.0	7.9	3.91	9.33	0.0	0.0	5	4.53	13.42	0.0	0.0	6
AUG	2.52	6.83	0.0	0.0	6.8	3.04	7.89	0.0	0.0	5	2.56	6.49	0.0	0.0	5
SEP	3.29	9.59	0.0	0.0	6.7	3.64	8.47	0.0	0.0	5	3.49	12.21	0.0	0.0	4
OCT	2.63	12.05	0.0	0.0	6.6	2.96	8.91	0.0	0.0	4	2.42	8.19	0.0	0.0	3
NOV	3.77	10.81	T	1.3	8.2	3.84	11.03	0.0	0.7	5	3.97	11.75	0.0	0.0	5
DEC	3.87	10.00	0.3	5.4	9.1	4.36	10.79	0.4	8.5	6	4.84	11.69	0.2	5.0	6
YEAR	43.84	17.11	1.8	5.9	97.1	49.12	19.56	2.6	11.9	68	49.56	13.42	1.4	8.7	66

* To convert to centimeters: cm = in x 2.54

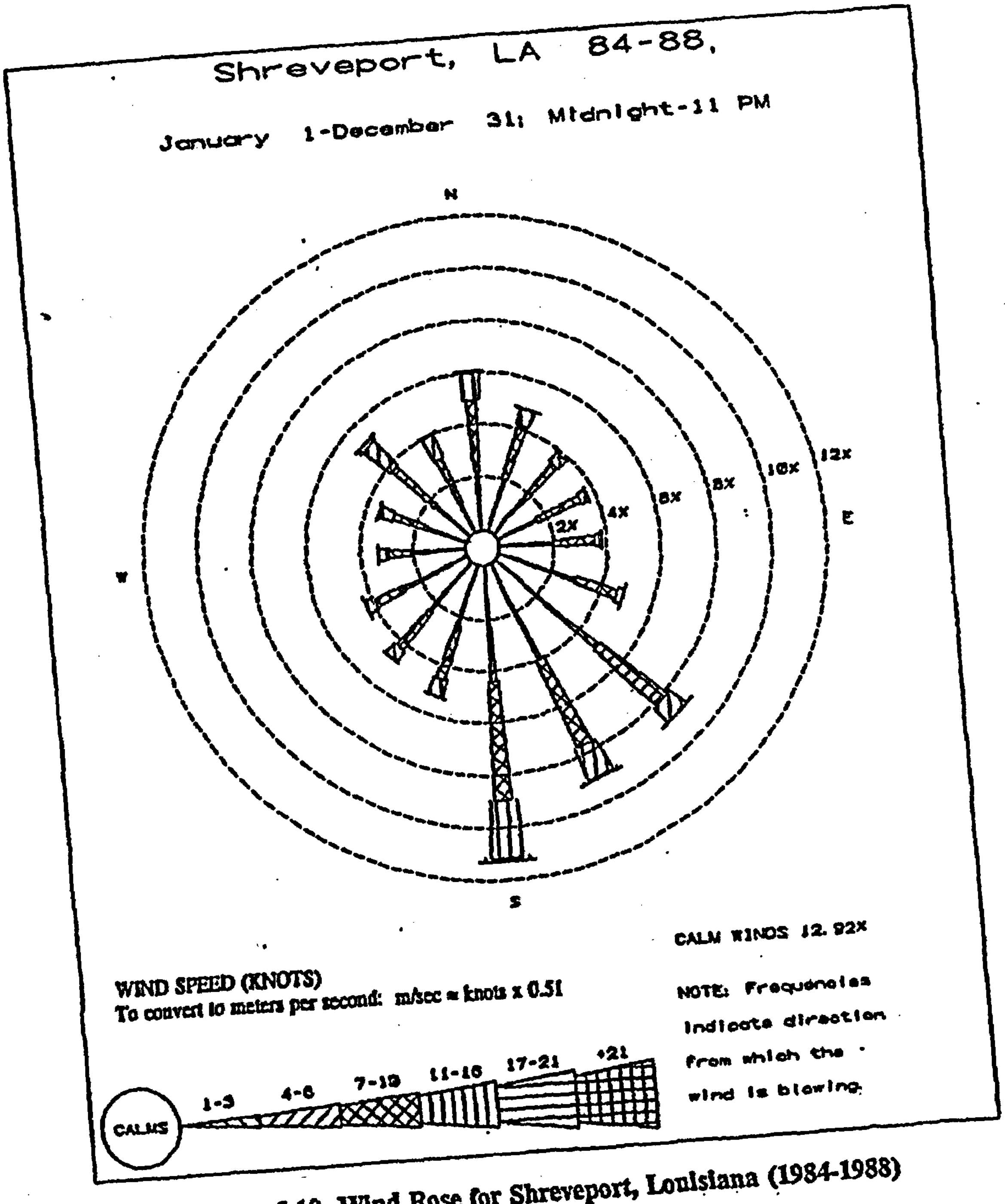

Figure 3.18 Wind Rose for Shreveport, Louisiana (1984-1988) (NOAA, 1990)

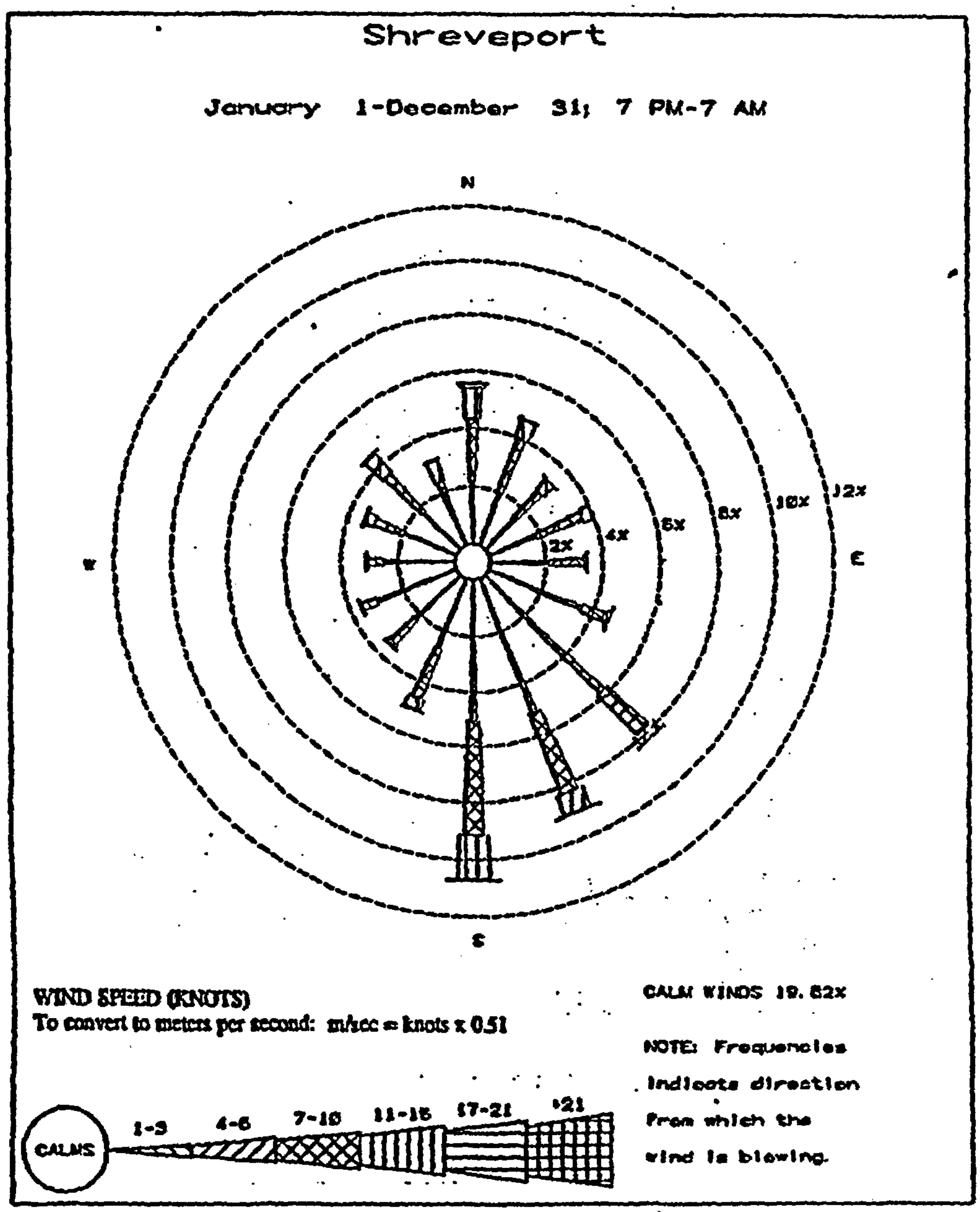

Figure 3.19 Nighttime Wind Rose for Shreveport, Louisiana (1984-1988) (NOAA, 1990)

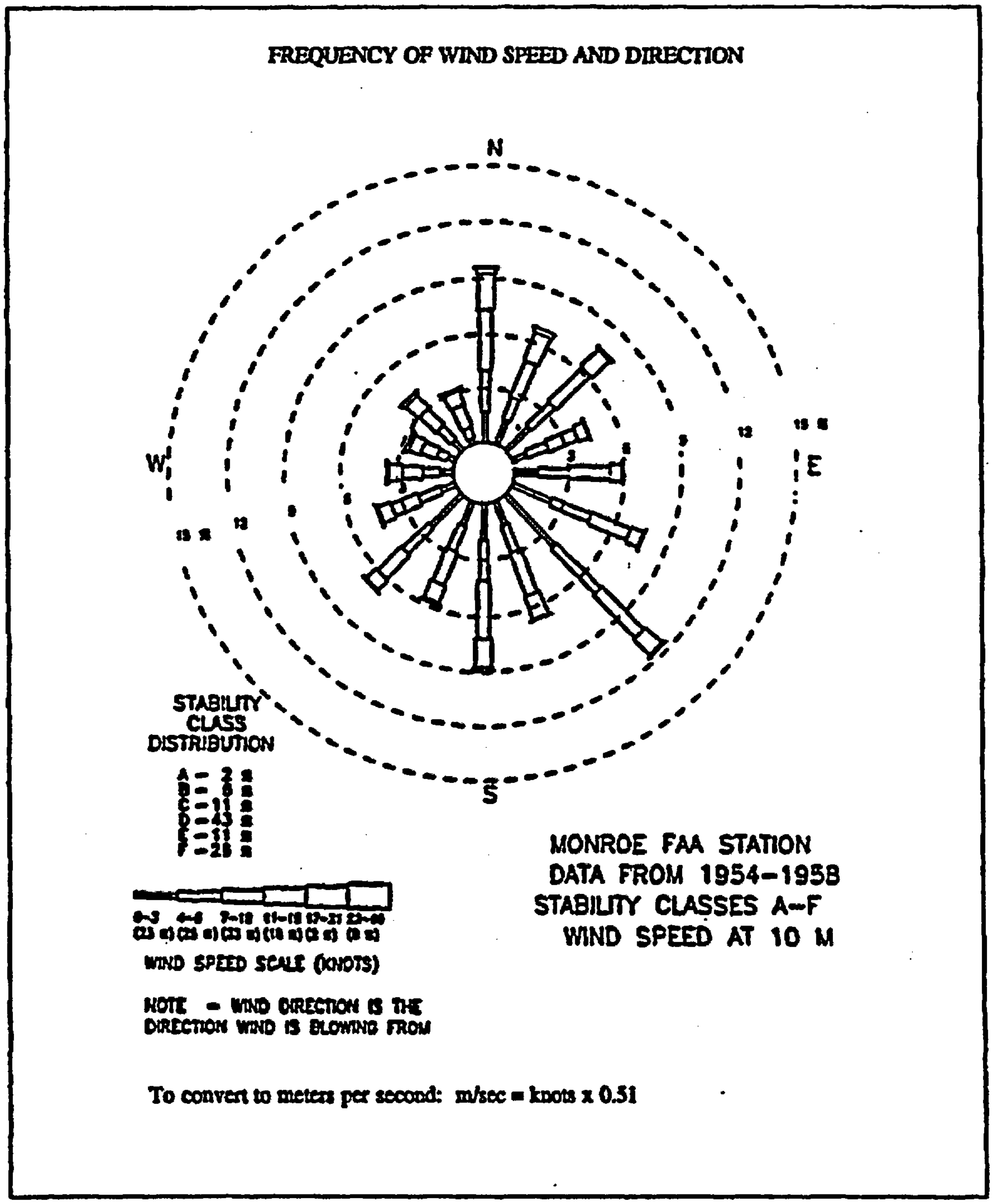

Figure 3.20 Wind Rose for Monroe, Louisiana (1954-1958) (LES, 1994a)

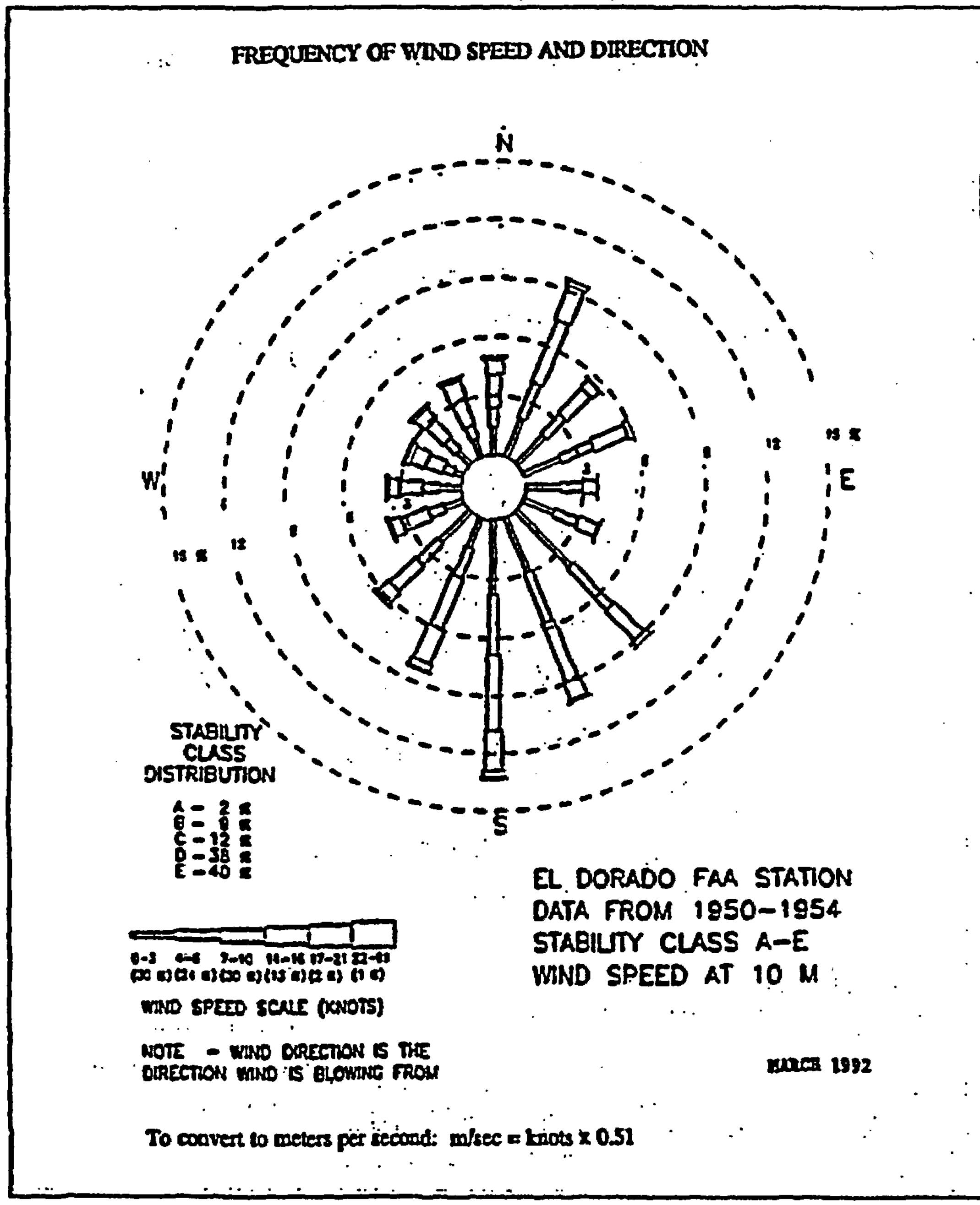

Figure 3.21 Wind Rose for El Dorado, Arkansas (1950-1954) (LES, 1994a)

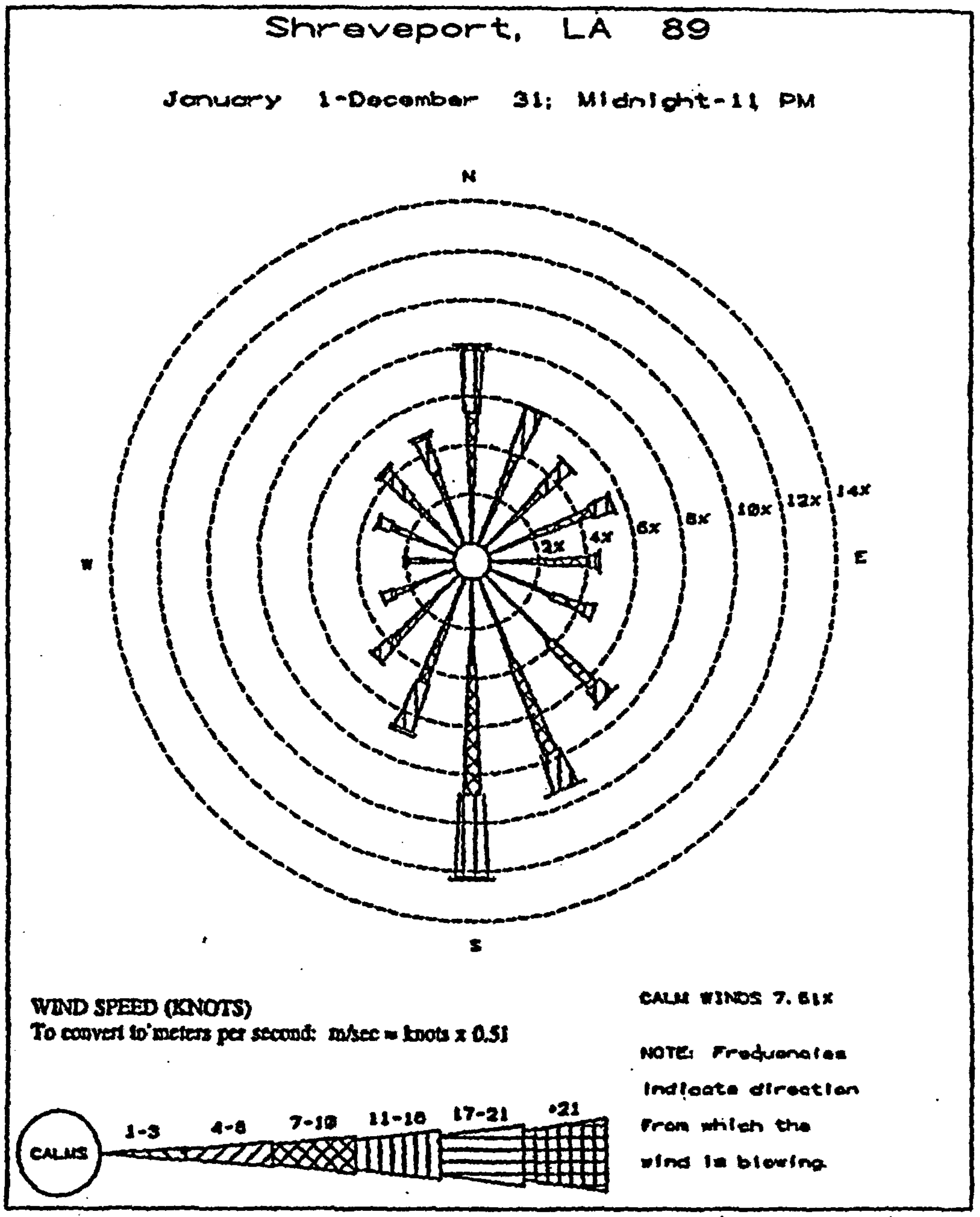

Figure 3.22 Wind Rose for Shreveport, Louisiana (1989) (NOAA, 1990)

Onshore airflow from the Gulf of Mexico causes southerly winds to prevail most of the year. Cold fronts cause northerly flows. The percentage of time wind blows in a certain direction during each month of the year is shown in Table 3.25. Table 3.26 shows the annual percentage of time that wind blows at various wind speeds. (Note: These reported speeds are lower than actual due to poor measurement location.) Due to the strong directionality of the wind, some stability classification methods may show significantly more stable atmospheric conditions than other methods. Because the site receives more insolation than most sites nationwide and has high humidity, the site would be considered to have less stability (more dispersion) than many other sites with similar factors. Table 3.27 presents the Stability Array (STAR) data for a 5-year period (1984-1988) at Shreveport, Louisiana. These data demonstrate frequent stable conditions, although this may result in part from collecting the data at a low tower height. However, any modeling of the dispersion of pollutants would overestimate the impacts on nearby receptors, and actual exposures would be less than those indicated by the model.

Mixing heights and controlling inversion layers typically have large diurnal variations. Table 3.28 shows the seasonal morning and afternoon mixing heights and wind speeds at Homer, Louisiana (Holzworth, 1972). Summer has the greatest mixing heights and lowest wind speeds of any season in the afternoon, while spring has the greatest morning mixing heights. The mixing heights and wind speeds are fairly typical of the interior United States. Pollution episode conditions are defined by the National Air Pollution Potential Forecasting Program as the combination of: (1) mixing heights under 1,500 m (4,900 ft); (2) wind speeds under 4.0 m/sec (8.9 mph); and (3) no significant precipitation. Holzworth's maps show that Shreveport, the closest meteorological station to the site to have upper air data, reported 13 pollution episodes lasting at least 48 hours and 32 pollution episode-days during the 5-year period from 1960 to 1964 (Holzworth, 1972). Fall pollution episodes predominated, with no episode lasting more than 5 hours. Spring afternoons appear to offer the best dispersion combinations of mixing heights and wind speeds, whereas autumn mornings seem to have the worst.

3.4.4 Air Quality

Claiborne Parish is located in the Shreveport-Texarkana-Tyler Air Quality Control Region (AQCR), AQCR 022. The AQCR is better than National Ambient Air Quality Standards (NAAQS) for total suspended particulates (TSP) and sulfur oxides (SO_x). The AQCR is either not characterized or is better than NAAQS for ozone (O_3), nitrogen oxides (NO_x), and carbon monoxide (CO). The NAAQS are shown in Table 3.29, and air quality data for Louisiana is presented in Table 3.30. It should be noted that the TSP values shown in Table 3.30 reflect TSP values prior to redefining TSP to be limited to particulate matter less than 10 micrometers (μm) in diameter. The change in definition was due to studies that showed adverse health effects were caused by only the smaller particulates (i.e., respirable size). In 1987, data for Shreveport showed a highest geometric mean TSP concentration of 31 micrograms per cubic meter ($\mu g/m^3$) (EPA, 1989), which is well below the 53.47 value

Table 3.25 Shreveport, Louisiana Monthly Wind Direction Frequencies, Percent (Department of Commerce, 1979)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N	5	7	6	4	4	3	2	4	8	7	7	4
NNE	6	6	5	3	4	3	3	4	10	8	6	6
NE	4	4	4	3	3	3	4	4	6	5	4	4
ENE	4	4	5	4	3	4	3	5	8	5	5	4
E	3	5	4	4	4	4	3	5	7	5	4	3
ESE	6	6	6	6	6	6	6	7	9	8	5	6
SE	7	8	8	9	11	10	11	11	10	10	7	9
SSE	11	8	10	16	15	12	12	12	9	10	11	11
S	14	13	13	17	17	18	16	13	8	10	13	11
SSW	6	6	7	4	6	13	13	10	4	4	5	6
SW	2	3	3	3	5	6	8	7	2	3	3	3
WSW	2	3	3	3	3	4	6	4	2	2	2	4
W	4	3	3	4	3	2	2	3	2	2	1	4
WNW	8	6	6	5	4	2	2	2	2	4	6	8
NW	8	8	7	5	4	2	2	2	2	6	8	7
NNW	8	7	7	6	4	3	2	2	5	6	9	7
CALM	2	3	3	4	4	5	5	5	6	5	4	3

Table 3.26 Percent of Time Winds Blow at Each Wind Speed in Shreveport, Louisiana (LES, 1992c)

Stability Class	Wind Speed (m/sec)						
	1.5	2.5	4.3	6.8	9.5	12.5	Total
A	0.26	1.02	0.00	0.00	0.00	0.00	1.28
B	1.18	4.17	2.96	0.00	0.00	0.00	8.31
C	0.34	4.13	8.84	1.20	0.03	0.00	14.54
D	0.89	9.71	20.49	12.46	1.01	0.13	44.70
E	0.00	7.35	7.26	0.00	0.00	0.00	14.61
F	1.52	12.18	0.00	0.00	0.00	0.00	13.70
G	2.85	0.00	0.00	0.00	0.00	0.00	2.85
Total	7.05	38.57	39.55	13.66	1.04	0.14	100.00

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS A	N	0.000424	0.001050				
	NNE	0.000242	0.000309				
	NE	0.000242	0.000547				
	ENE	0.000242	0.000273				
	E	0.000363	0.000525				
	ESE	0.000302	0.000410				
	SE	0.000363	0.000684				
	SSE	0.000424	0.000525				
	S	0.000666	0.000958				
	SSW	0.000484	0.000365				
	SW	0.000424	0.000776				
	WSW	0.000424	0.000684				
	W	0.000484	0.000662				
	WNW	0.000302	0.000388				
	NW	0.000545	0.000456				
	NNW	0.000181	0.000251				

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS B	N	0.001430	0.003150	0.002214			
	NNE	0.000677	0.001643	0.001278			
	NE	0.000639	0.001849	0.001232			
	ENE	0.000639	0.001575	0.000936			
	E	0.001279	0.002465	0.001757			
	ESE	0.001129	0.002100	0.001324			
	SE	0.001129	0.002922	0.001666			
	SSE	0.001204	0.002168	0.001552			
	S	0.001957	0.004246	0.003561			
	SSW	0.000941	0.002009	0.001757			
	SW	0.001054	0.002328	0.002283			
	WSW	0.001279	0.002648	0.001780			
	W	0.001317	0.002442	0.001780			
	WNW	0.000828	0.001369	0.000662			
	NW	0.000639	0.001849	0.001050			
	NNW	0.000790	0.001529	0.000936			

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS C	N	0.000414	0.003196	0.007671	0.000776		
	NNE	0.000258	0.000258	0.003150	0.000410		
	NE	0.000258	0.001735	0.003196	0.000410		
	ENE	0.000155	0.001255	0.002648	0.000273		
	E	0.000569	0.002305	0.005228	0.000296		
	ESE	0.000414	0.002442	0.004269	0.000456	0.000045	
	SE	0.000828	0.002968	0.006255	0.000639		
	SSE	0.000724	0.002420	0.005410	0.000936		
	S	0.000776	0.005045	0.011529	0.002191	0.000068	0.000022
	SSW	0.000465	0.002146	0.004497	0.000662		
	SW	0.000310	0.002716	0.004885	0.000639	0.000022	
	WSW	0.000776	0.002671	0.004977	0.000616	0.000022	
	W	0.000310	0.001780	0.003561	0.000639		
	WNW	0.000207	0.001141	0.002442	0.000342	0.000045	
	NW	0.000155	0.001392	0.003515	0.000616	0.000022	
	NNW	0.000155	0.001369	0.003744	0.000502		

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS D	N	0.001696	0.007899	0.018561	0.012648	0.001210	0.000022
	NNE	0.000824	0.005205	0.011621	0.004452	0.000342	0.000022
	NE	0.000727	0.003972	0.009018	0.003356	0.000022	
	ENE	0.000775	0.004452	0.009429	0.002968	0.000045	
	E	0.001212	0.006712	0.010547	0.002716	0.000091	
	ESE	0.001115	0.007876	0.008196	0.001849	0.000091	0.000045
	SE	0.002618	0.010319	0.017123	0.006232	0.000273	0.000022
	SSE	0.001745	0.007351	0.020045	0.009292	0.000707	0.000136
	S	0.001696	0.010547	0.030365	0.024611	0.001735	0.000114
	SSW	0.000533	0.003515	0.008744	0.004817	0.000319	
	SW	0.000824	0.003652	0.006301	0.004109	0.000136	
	WSW	0.000775	0.002762	0.003652	0.002853	0.000319	0.000091
	W	0.000290	0.002625	0.003858	0.004109	0.000570	0.000068
	WNW	0.000533	0.002123	0.005662	0.005388	0.000570	0.000365
	NW	0.000581	0.003036	0.008219	0.011118	0.001575	0.000182
	NNW	0.000533	0.002511	0.007100	0.008013	0.000776	0.000091

Note: Blank spaces represent zero values.

**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS E	N		0.003630	0.006415			
	NNE		0.002397	0.003173			
	NE		0.001940	0.002442			
	ENE		0.002031	0.003470			
	E		0.004863	0.003013			
	ESE		0.005707	0.001643			
	SE		0.009178	0.002945			
	SSE		0.007488	0.004840			
	S		0.010570	0.012123			
	SSW		0.003219	0.003972			
	SW		0.002945	0.002100			
	WSW		0.002762	0.001415			
	W		0.002785	0.002237			
	WNW		0.001643	0.004406			
	NW		0.001712	0.005547			
	NNW		0.001164	0.003424			

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS F	N	0.001353	0.006735				
	NNE	0.000925	0.004337				
	NE	0.001139	0.002123				
	ENE	0.000783	0.003470				
	E	0.002848	0.005753				
	ESE	0.004059	0.006963				
	SE	0.007762	0.008995				
	SSE	0.004201	0.008949				
	S	0.004842	0.017853				
	SSW	0.001780	0.007100				
	SW	0.001495	0.005000				
	WSW	0.004344	0.006780				
	W	0.003845	0.009018				
	WNW	0.001139	0.006095				
	NW	0.000498	0.004977				
	NNW	0.000142	0.001940				

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.27 Shreveport, Louisiana Stability Array for 1984-1988 (LES, 1994a) (Continued)

Wind Sector		MAXIMUM WIND SPEED IN KNOTS*					
		1.5	2.5	4.3	6.8	9.5	12.5
CLASS G	N	0.002940		0.000005			
	NNE	0.001802					
	NE	0.001612					
	ENE	0.001327					
	E	0.002750					
	ESE	0.008821					
	SE	0.012994					
	SSE	0.013089					
	S	0.010623					
	SSW	0.004837					
	SW	0.004173					
	WSW	0.012899					
	W	0.017168					
	WNW	0.005596					
	NW	0.001233					
	NNW	0.001233					

Note: Blank spaces represent zero values.
**Data was taken at 6.1 m (20 ft) rather than the standard 10 m (32.8 ft), which results in slightly lower reported wind speeds; to convert to meters per second: m/s = knots x 0.51*

Table 3.28 Seasonal Mixing Heights and Wind Speeds at Homer, Louisiana (Holzworth, 1972)

	Morning		Afternoon	
Period	Mixing Height (Meters)	Wind Speed (m/sec)	Mixing Height (Meters)	Wind Speed (m/sec)
Winter	500	6.0	1,000	6.5
Spring	550	6.0	1,400	7.0
Summer	500	4.0	1,800	5.0
Fall	400	4.5	1,400	5.5
Annual	500	5.0	1,400	6.0

Table 3.29 National Primary and Secondary Ambient Air Quality Standards

Pollutant	Averaging Time	Primary	Secondary
SO_2	Annual Arith. Mean	80 $\mu g/m^3$	
	24 Hours	365 $\mu g/m^3$	
	3 Hours		1,300 $\mu g/m^3$
TSP	Annual Arith. Mean	50 $\mu g/m^3$	50 $\mu g/m^3$
	24 Hours	150 $\mu g/m^3$	150 $\mu g/m^3$
Ozone (O_3)	1 Hour	235 $\mu g/m^3$	235 $\mu g/m^3$
NO_X	Annual Arith. Mean	100 $\mu g/m^3$	100 $\mu g/m^3$
Lead	3 Months	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
CO	8 Hours	10 mg/m^3	
	1 Hour	40 mg/m^3	

shown in the table. Thus, although Shreveport was in nonattainment for TSP in 1985, due to the change in definition of TSP, it is now in attainment for all air pollutants (EPA, 1992). Due to the good air quality in the region, there are very few monitoring stations in northern Louisiana; none are close to the site.

Table 3.30 Louisiana Air Quality ($\mu g/m^3$) (EPA, 1985)

Site	Pollutant	Year	Maximum	Arithmetic Average	Geometric Mean	Percentile 50	Percentile 95
Monroe	TSP	1984	151	57	52.39	50	102
Homer	TSP	1984	80	47	44.01	44	75
Shreveport	TSP	1984	107	58	53.47	55	95
Baton Rouge	TSP	1984	104	57	54.07	55	88
Shreveport	Lead	1984	0.43			0.14	0.43
Baton Rouge	Lead	1984	2.63			0.23	2.65
Baton Rouge	Carbon Monoxide	1984	11,300	800	570	300	2,100
Monroe	Sulfur Dioxide	1984	123	8	5.06	3	31
Shreveport	Sulfur Dioxide	1984	126	8	5.19	3	26
Baton Rouge	Sulfur Dioxide	1984	582	16	7.60	5	58
Baton Rouge	Nitrogen Dioxide	1984	62	34	32.19	32	40
Monroe	Nitrogen Dioxide	1984	72	37	33.72	32	43
Shreveport	Nitrogen Dioxide	1984	94	36	27.95	30	44
Monroe	Ozone	1984	0.103	0.042	0.04	0.039	0.074
Shreveport	Ozone	1984	0.109	0.041	0.04	0.037	0.079
Baton Rouge	Ozone	1984	0.161	0.047	0.04	0.041	0.098

3.5 Biotic Resources

This section provides a baseline description of the biotic resources and the terrestrial and aquatic communities at the proposed CEC site, prior to any disturbances associated with the construction or operation of the CEC. Prior environmental disturbances not associated with the CEC and their effect on the site's ecology are considered when describing the baseline conditions. The baseline conditions described are those that existed after extensive timbering, which occurred in the spring and early summer of 1990.

Inventories of the flora (Rhodes, 1990), avifauna (Goertz, 1990a and 1990b), and aquatic communities (Davis, 1990b) at the proposed CEC site were performed. The animal species at the site were assessed by comparing them with species typical of other southeastern mixed forest systems (Bailey, 1980). For each major community at the proposed site, the plant and animal species that comprise the community are identified, and their distribution and relative abundance are discussed. Based on these initial assessments, important species were identified (NRC, 1975a). The following criteria were applied to identify important species:

(1) The species is commercially or recreationally valuable.

(2) The species is threatened or endangered, as defined in the Endangered Species Act of 1973, as amended (P.L. 93-205).

(3) The species affects the well-being of one or more important species identified using Criteria 1 or 2.

(4) The species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment.

The important species are further described by their interrelationship with the environment at the site, including their habitat requirements, life history, and population dynamics. Pre-existing environmental stresses that may have impacted the ecological integrity of the site and affected important species are also identified.

Terrestrial and aquatic communities are addressed in the following three subsections: Section 3.5.1, which discusses the botanical communities; Section 3.5.2, which discusses the terrestrial wildlife communities; and Section 3.5.3, which discusses the aquatic communities. Threatened and endangered species and critical habitats that may be present at the site are identified in the discussions of each community.

3.5.1 Botanical Communities

The botanical communities present at the proposed CEC site generally reflect the range of plant communities that lie in the Western Hills subprovince of the Gulf Coastal Plain physiographic province (Evans et. al, 1983). This region was covered at one time primarily

by mixed pine and hardwood forests, and some areas of the region still reflect this forest structure. However, forestry and agricultural practices have changed the vegetative communities of most of the region. Currently, pines, primarily loblolly *(Pinus taeda)* and short leaf *(Pinus palustrius)* pine, are the dominant species on most forested upland sites within the region. Alluvial forests dominated by mixed hardwood species occur in the bottomlands along the drainage ways and streams that dissect the region.

A botanical survey was conducted at the proposed CEC site in June 1990 (Rhodes, 1990), and five distinct plant communities were identified (Figure 3.23). These are, in order of their prevalence at the site:

(1) upland mixed forest--recent harvest
(2) upland mixed forest--several years since harvest
(3) upland forest--pine-dominated
(4) upland mixed forest--mature
(5) bottomland hardwood forest

The following qualitative terms are used to describe the degree of prevalence of each species:

- Dominant: the most prevalent species within a given vegetative community based on considerations of biomass (qualitatively determined by the number and size of individual species). A community may have one or more dominant species or no dominant species.

- Common: a species that has a high probability of being noted at any random point within a specific vegetative community.

- Moderate: a species that may or may not be observed at any random point within a specific vegetative community, but may be located with a limited amount of searching.

- Scattered: a species that occurs only a few times within a given vegetative community, or a species that is abundant in only one or two localized areas.

3.5.1.1 Upland Mixed Forest--Recent Harvest

Upland mixed forest implies a mixture of pine and hardwood that is not subject to inundation by water at any time. Most of this area was clearcut during late winter through early summer of 1990. Recently harvested upland mixed forest is the dominant vegetative community on the proposed CEC site, occupying 61 percent, or about 110 hectares (271 acres), of the total land area (179 hectares [442 acres]) of the LES property. As shown in Figure 3.23, the majority of the recently harvested area lies west of Parish Road 39,

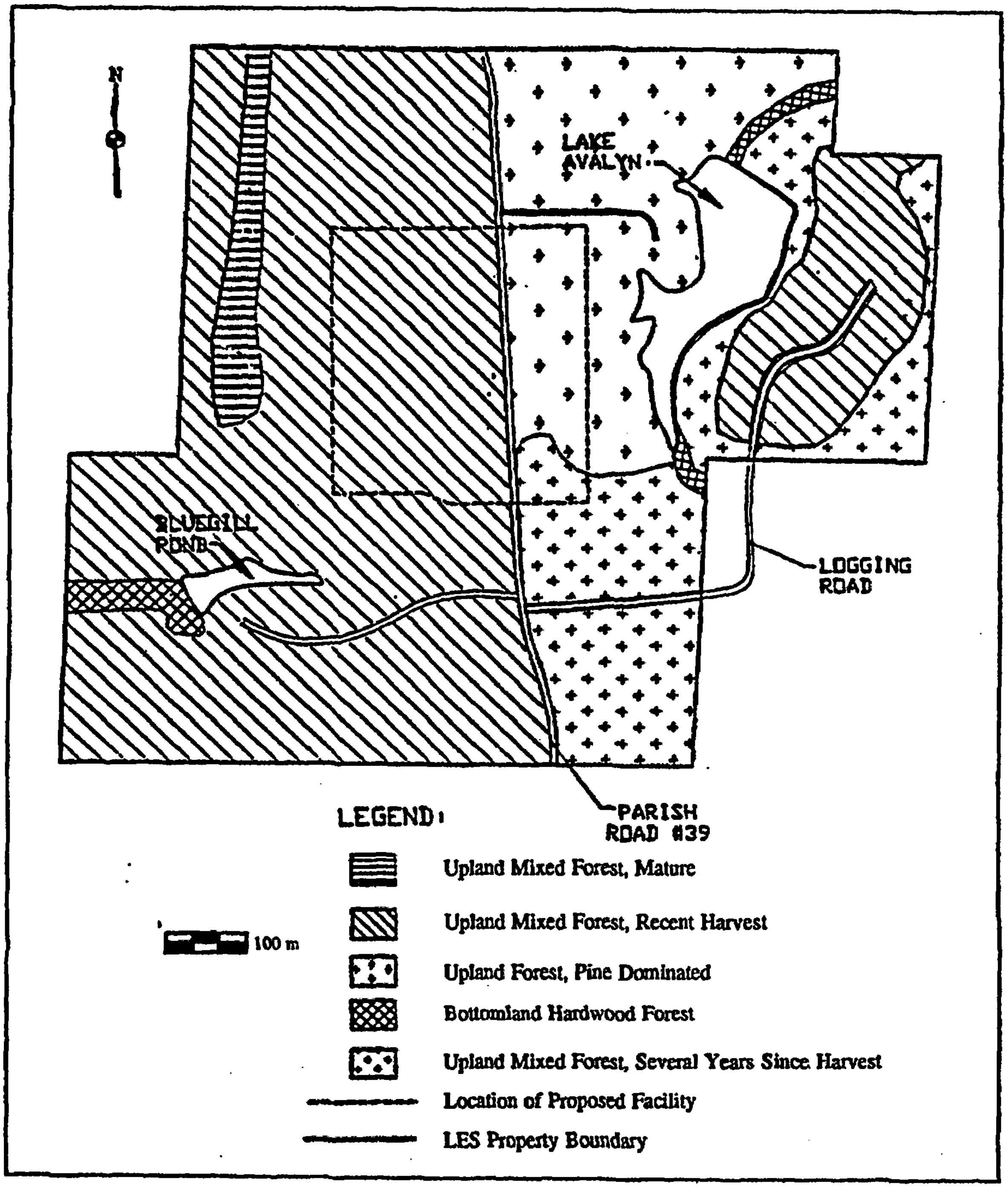

Figure 3.23 Principal Vegetative Communities at the Proposed CEC Site (LES, 1994a)

dominating the entire western half of the LES property. The remaining portion lies east of Lake Avalyn.

Numerous species of herbaceous plants occur throughout the recently harvested upland mixed forest. Many of these species are invaders such as panic grass (*Dichanthelium sp.*), dogfennel (*Eupatorium capillifolium*), fireweed (*Erechtites hieracifolia*), partridge pea (*Cassia sp.*), tick trefoil (*Desmodium sp.*), dewberry and blackberry (*Rubus sp.*), grape (*Vitis sp.*), doveweed (*Croton capitatus*), and lespedezea (*Lespedezea sp.*). LES (1994a) has completed a detailed list of the botanical species present in the recently harvested upland mixed forest at the site and their relative abundance.

3.5.1.2 Upland Mixed Forest--Several Years Since Harvest

The plant communities associated with the upland mixed forest--several years since harvest-areas differ slightly from those in the forested areas. Most of this area probably was harvested around 1980 or earlier, but some areas may have been harvested as recently as 1985. Vegetation in the older cut areas is dominated by sweetgum (*Liquidambar styraciflua*) and loblolly pine (*Pinus taeda*). Red maple (*Acer rubrum*), American beauty berry (*Callicarpa americana*), and persimmon (*Diospyros virginiana*) are also common. Vegetation in the younger cut areas is dense, comprised of a variety of woody and herbaceous species. A few small logging roads and small clearings also exist in the area. Previously harvested upland mixed forest occupies about 17 percent, or 30 hectares (75 acres), of the total land area of the LES property. As shown in Figure 3.23, all of the formerly harvested upland mixed forest lies east of Parish Road 39, primarily south and east of Lake Avalyn.

The botanical species present in the formerly harvested upland mixed forest at the site, along the roadsides, and in clearings of this area, along with their relative abundance, are listed by LES (1994a).

3.5.1.3 Upland Forest--Pine-Dominated

Loblolly pine (*Pinus taeda*) is the dominant species in the pine-dominated upland forest area. The hardwood species present in the mixed upland forests of the site also occur here, but in much smaller numbers. The forest is well developed; future succession should not change the composition to any extent. Carpet grass and dogfennel are common in this environment. Very few herbaceous plants occur on the thatch-covered floor of a pine-dominated forest; the herb and vine listing refers only to roadsides and cleared areas. Pine-dominated upland forest occupies about 16 percent, or 28 hectares (70 acres), of the total land area of the LES property. As shown in Figure 3.23, the pine-dominated upland forest occurs east of Parish Road 39 and west and north of Lake Avalyn.

LES (1994a) lists the botanical species present in the upland pine forest at the site and their relative abundance.

3.5.1.4 Upland Mixed Forest--Mature

In the mature upland mixed forest, Loblolly pine (*Pinus taeda*), southern red oak (*Quercus falcata*), and red maple (*Acer rubrum*) dominate the overstory, but white oak (*Quercus alba*), black gum (*Nyssa sylvatica*), and water oak (*Quercus nigra*) also occur frequently. The understory of this forest is much sparser than in the mixed forests that were harvested within the last 10 years (discussed above). Mature upland mixed forest occupies about 4 percent, or 7 hectares (18 acres), of the total land area of the LES property. It is not known if this area is to be timbered in the near future. This thin strip of forest that occurs near the western border of the LES property represents the most mature stand of timber.

LES (1994a) lists the botanical species present in the mature mixed upland forest at the LES site property and their abundance.

3.5.1.5 Bottomland Hardwood Forest

Bottomland hardwood forests include all forested areas subject to inundation by floodwater for up to 3 months each year. Consequently, botanical species that adapt to wet environments predominate the plant community. Common trees of the bottomland forests at the site include red maple (*Acer rubrum*), sweetgum (*Liquidamba styraciflua)*, black gum (*Nyssa sylvatica*), common alder (*Alnus serrulata*), and blue beech (*Carpinus caroliniana*). Common herbaceous species include partridge berry (*Mitchella repens*), lady fern (*Athyrium filix-femina*), false nettle (*Boehmeria cylindrica*), and poison ivy (*Rhus toxicodendron*).

Bottomland hardwood forests are the least prevalent plant community on the site, occupying about 2 percent, or 3.6 hectares (9 acres), of the total area of the LES property. These forests, which are limited primarily to small areas adjacent to Lake Avalyn and Bluegill Pond, also line the larger drainages at the site.

The botanical species present in the bottomland hardwood forests at the LES property and their abundance are listed in LES (1994a).

3.5.1.6 Important Species

Based on communications with the U.S. Fish and Wildlife Service (Nichols, 1990) and the Louisiana Natural Heritage Program (LNHP) (Martin, 1990 and Lester, 1992), no Federally endangered or threatened botanical species have been identified on or near the LES property. However, the LES property contains a number of commercially valuable timber species that are considered important species. The timber species that occur most frequently on the proposed CEC site (i.e., those identified in the previous section as being dominant or common) are listed in Table 3.31.

Several rare State plant species have been documented within a 24-km (15-mile) radius of Homer, Louisiana. These could be present at the site, although they were not described

Table 3.31 Commercially Important Timber Species Commonly Identified at the Proposed CEC Site (LES, 1994a)

Common Name	Scientific Name
Sweetgum	*Liquidambar styraciflua*
White Ash	*Fraxinus americana*
Oak	*Quercus spp.*
Red Maple	*Acer rubrum*
Black Cherry	*Prunus serotina*
Black Gum	*Nussa sylvatica*
Hickories	*Carya spp.*
Loblolly Pine	*Pinus taeda*

during the site botanical survey conducted in June 1990 (Rhodes, 1990). These species are listed in Table 3.32 along with their State ranking assigned by the LNHP. However, these species are not endangered or threatened as defined under the Endangered Species Act, nor do they meet any of the other criteria of important species as defined in NRC Regulatory Guide 4.9; therefore, they are not selected as important species for the CEC site (NRC, 1975a).

Table 3.32 Rare State Plant Species Potentially Identified at the Proposed CEC Site (LES, 1994a)

Common Name	Scientific Name	Louisiana Natural Heritage Program Common Name (LNHP) Ranking[a]
Long's Yellow Star-Grass	*Hypoxis longii*	SU
Evening Primrose	*Oenothera sessilis*	S3
Deer-Tongue Witchgrass	*Panicum clandestinum*	S1
Bloodrot	*Sanguinaria candensis*	S2
Reflexed Trillium	*Trillium recurvatum*	SU

[a] SU = Possibly in peril in the State, but status uncertain.
S1 = Critically imperiled in the State because of extreme rarity (five or fewer occurrences or few remaining individuals or acres) or because of other factors making it especially vulnerable to extirpation from the State.
S2 = Imperiled in the State because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of other factors making it very vulnerable to extirpation.
S3 = Rare or uncommon in the State (21 to 100 occurrences).

3.5.1.7 Pre-Existing Environmental Stresses

Pre-existing environmental stresses on the botanical communities at the proposed CEC site consist of timbering (including 1990 clearcutting) and grazing. Timbering has had the largest effect on vegetation at the site; 61 percent of the total land area of the site had been

clearcut in 1990, and 94 percent of the total land area has been timbered in the past 10 years. Timbering alters the composition, structure, and function of the plant community. In general, forest communities are more productive and have greater stability and structural diversity than the herb- and shrub-dominated communities which occur as a result of timbering. The result of timbering, particularly clearcutting, is a movement of the plant community to earlier stages of succession. Heavier degrees of cutting, as well as exposure of mineral soil, initiate earlier stages of succession. All vegetation has been removed from a 0.4-hectare (1-acre) area just south of the small onsite pond, exposing the mineral soil.

Cattle on the site graze in the upland mixed forest and in the pine-dominated upland forest east of Parish Road 39. Grazing maintains herbaceous-dominated communities characteristic of earlier stages of succession; woody species, characteristic of later stages of succession, are not established extensively in grazed areas. This pattern was apparent in the grazed areas at the site, which were interspersed with small clearings dominated by herbaceous plants. The forests established in the pasture areas indicate that grazing began after forest species were established, or that grazing has not been intense or extensive enough to inhibit forest regeneration across the entire area.

The roads constructed at the CEC site also constitute a pre-existing environmental stress. The open areas associated with the roads (i.e., vegetated areas without canopy cover) often support herbaceous species different than those present on the forest floor. This pattern was apparent near roads in the upland mixed forest areas that were harvested 5 to 10 years ago (Rhodes, 1990).

3.5.1.8 Species-Environment Relationships for Important Species

The abundance and distribution of commercially important timber species at the proposed CEC site depends upon the interaction of these species with their environment. This interaction reflects in the successional processes occurring within the botanical community. As a result of pre-existing environmental stresses, particularly timbering, the successional stages of several of the forest communities at the site have been altered, moving toward earlier stages of succession. Over time, however, these communities will progress toward the more productive, more stable, and structurally more complex forest communities that they were before timbering. Because of this continual change, the baseline plant communities used to evaluate potential impacts of the CEC will change constantly. Therefore, any predictions of potential impacts of the CEC must necessarily consider the natural successional processes that will occur at the site.

Based on a knowledge of the existing plant communities at the site, as well as a knowledge of the pretimbering plant communities, the species composition of future communities at the site can be predicted. For the plant communities identified at the site, the probable successional sequence of plant species is discussed below. The effects of succession on the abundance and distribution of commercially important timber species at the CEC site are also discussed.

As discussed previously, the upland mixed forest--recently harvested vegetative community is comprised of a variety of herbaceous species, many of them (e.g., panic grass, dogfennel, fireweed) termed "invader species" because they exhibit the ability to quickly colonize disturbed areas. These species will continue to thrive over the next few years in the recently disturbed areas. In areas where the mineral soil has been exposed, these and other invader species probably will dominate the plant community for a longer period of time. As this vegetative community matures toward a forested system, these invader herbaceous species will no longer be present; other herbaceous and woody species better adapted to the changing conditions in the developing community will begin to dominate.

Young woody plants typical of these slightly later stages of succession already have begun to appear in less disturbed parts of the clearcut area. Among these are sassafras (*Sassafras albidum*), sweetgum (*Liquidambar styraciflua*), winged sumac (*Rhus copallina*), persimmon (*Diospyros virginiana*), and loblolly pine (*Pinus taeda*). These species should dominate the new forest in the less disturbed areas for the next 5 to 10 years. However, as the new forest matures, commercially important timber species are likely to become dominant. In addition, several oaks (*Quercus spp.*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), and other woody species that have sprouted from existing root systems will make an immediate impact upon the new forest.

The upland mixed forest--several years since harvest - community is dominated by sweet gum (*Liquidambar styraciflua*) and loblolly pine (*Pinus taeda*). These commercially important timber species probably will remain the dominant species as this forest reaches maturity. Common species at the maturity stage would include red maple (*Acer rubrum*), southern red oak (*Quercus falcata*), bitternut hickory (*Carya cordiformis*), white oak (*Quercus alba*), black gum (*Nyssa sylvatica*), mockernut hickory (*Carya tomentosa*), and water oak (*Quercus nigra*). The greatly-thinned understory will be represented primarily by such species as hop hornbeam (*Ostrya virginiana*), American holly (*Ilex opaca*), Indian cherry (*Rhamnus caroliniana*), wax myrtle (*Myrica cerifers*), and flowering dogwood (*Cornus florida*).

The pine-dominated upland forest community is currently dominated by the loblolly pine (*Pinus taeda*). Pine regeneration is much stronger in this forest area than in any other portion of the proposed CEC site. This well-developed forest is unlikely to experience succession that would change the species composition to any significant extent.

The mature upland mixed forest community represents the most mature stand of timber on the LES property and provides an example of the forest composition west of Parish Road 39 before the clearcutting. Although some changes in composition might occur, succession in the recently clearcut areas may proceed toward the species composition currently observed in this mature upland forest. It is unlikely that succession will significantly modify the species composition in this mature forest.

The species composition of the bottomland hardwood forests is determined by the hydrologic conditions of the area. Species that are adapted to withstand periodic inundation

have a competitive advantage over species better adapted to drier, upland conditions. Consequently, red maple (*Acer rudnum*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), common alder (*Alnus serrulata*), and blue beech (*Carpinus caroliniana*) are the common woody species in the bottomland hardwood forests on the LES property. Given the current species composition, it is unlikely that succession will result in significant changes in the species composition of the bottomland forests at the site; the understory will probably thin as the forest matures.

3.5.2 Terrestrial Wildlife Communities

The wildlife species on the LES property are most likely typical of southeastern mixed-forest systems, with a few exceptions. According to Bailey (1980), white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Silvilagus floridanus*), raccoon (*Procyon lotor*), red fox (*Vulpes fulva*), and gray fox (*Urocyon cinereoargenteus*) are common mammalian species in most southeastern mixed-forest systems. If deciduous trees are present on uplands, fox squirrels (*Sciurus niger*) are likely to be common; gray squirrels (*Sciurus carolinensis*) are more common along intersecting drainages where mature, nut-producing trees are present. Common game birds include wild turkey (*Meleagris gallopavo*), bobwhite quail (*Colinus virginianus*), and mourning dove (*Zenaida macroura*). Common song birds include Carolina wren (*Thryothorus ludovicianus*), ruby-throated hummingbird (*Archiloch colubris*), blue jay (*Cyancocitta cristata*), hooded warbler (*Wilsonia citrina*), and tufted titmouse (*Parus bicolor*). Reptiles include forest snakes such as cottonmouth (*Agkistrodon piscivorous*), copperhead (*Agkistrodon contortrix*), rough green snake (*Opeodrys aestivus*), coachwhip (*Masticophis flagellum*), and speckled kingsnake (*lampropeltis getulus*). Other animals include a variety of turtles and skunks (Bailey, 1980).

The particular species composition of the wildlife community at the site is a direct function of the type, quality, and quantity of available habitat. Factors such as the age of the timber stands, the percent of deciduous trees, the presence or proximity of openings within the forest, and the presence of bottomland forests directly influence the species composition at the site. Information on the particular habitats that exist at the site, along with information on the regional and local distribution of wildlife species and species-specific habitat preferences, can be used to identify the wildlife species likely to occur at the proposed CEC site. The mammals, birds, amphibians, and reptiles known or expected to be present on the CEC site are discussed below.

3.5.2.1 Mammals

The mammalian species common or known to occur at the site include beaver (*Castor canadensis*), gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), least shrew (*Cryptotis parva*), red bat (*Lasiurus borealis*), eastern cottontail (*Silvilagus floridanus*), opossum (*Didelphismarsupialis*), and white-tailed deer (*Odocoileus virginianus*). The species listed are those identified by the LNHP (Martin, 1990) as having been in the watershed that includes

the town of Homer, in Claiborne Parish, approximately 8 km (5 miles) from the site. No site-specific field survey was conducted at this time to identify mammals at the site.

LES (1994a) attempted to qualitatively estimate the distribution and abundance of each mammalian species potentially inhabiting the site. These estimates were based on knowledge of the species-specific habitat preferences and the current composition, structure, and extent of the vegetative communities at the site. The distribution and abundance of at least some of the mammalian species may change in the future, as the succession of the vegetative communities of the site continues, or as the vegetative communities are further affected by development of the area. For example, gray squirrels probably are not currently abundant at the site because a large percentage of the site's mature, nut-producing trees (such as oaks and hickories) that provide this species' food were removed during the recent clearcutting. However, the number of gray squirrels is likely to increase in the future as the mixed hardwood forests of the site regenerate and nut-producing trees mature. Minks can be found in the bottomland and along drainage ways; however, because of their large foraging range, the population of the species may be sparse. The gray fox and red fox may occur at the site, however, the whole site probably can support only one or two foxes.

3.5.2.2 Birds

From the Checklist of North American Birds (American Ornithologists' Union, 1983), 177 bird species were selectively chosen as those likely to live in or visit the region. Of these, approximately 96 species are likely to be summer residents and 78 may nest on the site. Approximately 93 of the 177 species are probable winter residents of the site. The LES identifies in great detail the bird species that may occur on the site along with the migratory and nesting status of each (1993b).

Three site-specific avian surveys were conducted during January 1990 (Goertz, 1990b) and another survey was conducted in April 1990 (Goertz, 1990a), to verify the presence of particular bird species at the site. (The January survey was conducted before the clearcutting occurred, and the April survey was conducted after the majority of the timber harvesting had been completed.) A total of 65 species were identified during these surveys; 40 of these species were identified during the January survey and 51 were identified during the April survey.

A breeding bird census also was conducted as part of the April survey (Goertz, 1990a). Breeding birds were identified for three of the five principal vegetative communities on the site: 1) upland mixed forests--several years since harvest; 2) mature upland mixed forest; and 3) upland mixed forest--recently harvested. In all, 198 territorial males of 41 species were identified for the site. The greatest number of territorial males was found in the upland mixed forest, which had not been harvested for several years; a large number of territorial males was found in the mature forest; and only four territorial males were found in the recently harvested upland mixed forest. The mature forest had a greater number of nestling species than either the recently harvested area or the upland mixed forest, which

has not been harvested for several years. Based on the total number of territorial males, it was estimated that approximately 160 nests occurred across the surveyed portions of the site (see Table 3.33 for a breakdown of the numbers).

Table 3.33 Breeding Birds Identified at the Proposed CEC Site (LES, 1994a)

	Upland Mixed Forest (Several Years since Harvest)	Mature Upland Mixed Forest	Upland Mixed Forest (Recently Harvested)
Number of Territorial Males	120	73	4
Number of Nestling Species	20	34	4

3.5.2.3 Amphibians and Reptiles

LES lists and identifies the amphibians and reptiles potentially inhabiting the site (1993b). The species listed are those identified by the LNHP (Martin, 1990) as having been in the watershed that includes the town of Homer, located in Claiborne Parish, approximately 8 km (5 miles) from the proposed CEC site.

The distribution of amphibians at the site correlates closely to the availability of water. Bluegill Pond and Lake Avalyn provide permanent or breeding habitats for a variety of amphibian species, including spotted salamander (*Ambystoma maculatum*), northern cricket frog (*Acris crepitans crepitans*), eastern narrowmouth toad (*Gastrophryne carolinesis*), bullfrog (*Rana catesbeiana*), and southern leopard frog (*Rana sphenocephala*). Swampy areas in the bottomland hardwood forests of the CEC site may provide permanent or breeding habitats for dwarf salamander (*Eurycea quadridigitata*) and upland chorus frog (*Pseudacris triseriata feriarum*), and streams of the area may support populations of northern dusky salamander (*Desmongnathus fuscus fuscus*) and bronze frog (*Rana clamitans*).

The water present at Bluegill Pond and Lake Avalyn determines or influences the distribution of some of the reptiles at the site. For example, any snapping turtles (*Cheldta serpentina serpentina*), red-eared sliders (*Chrysemys scripta elegans*), eastern mud turtles (*Kinosternon subrubrum subrubrum*), and stinkpots (*Sternotherus odoratus*) living at the site are likely to be confined to Bluegill Pond and Lake Avalyn. The distribution of diamondback water snake (*Nerodia rhombifera*) and western cottonmouth (*Agkistrodon piscivorous leucostoma*) also are determined by the presence of water (Conant, 1975). The distribution of the other reptiles at the proposed CEC site is not influenced significantly by the presence of water.

3.5.2.4 Important Species

No Federally- or State-listed endangered or threatened species have been identified at the proposed CEC site (Lester, 1992 and Martin, 1990). Moreover, no unique communities are known to exist on the LES property. Information from the U.S. Fish and Wildlife Service (Nichols, 1990) indicates that the CEC site is located within the historic range of six Federally-endangered wildlife species (Table 3.34). None of these species have been recorded within a 24-km (15-mile) radius of Homer, Louisiana (Martin, 1990). Furthermore, based on information regarding each species' historical occurrence in the area and species-specific habitat requirements, it is highly unlikely that any of these species would inhabit the site. If they did, they would not use the site to any significant degree. Recent clearcutting at the site probably would discourage habitation by any of these species.

Table 3.34 Federally-Endangered Wildlife Species Whose Known or Historic Distribution Encompasses the CEC Site (Goertz, 1990a)

Common Name	Scientific Name
Florida Panther	*Felis concolorcoryi*
Eskimo Curlew	*Numenius borealis*
Bachman's Warbler	*Vermivora bachmanii*
Ivory-billed Woodpecker	*Campephilus pricipalis*
Red-cockaded Woodpecker	*Picoides borealis*
Bald Eagle	*Haliaeetus leucocephalus*

Descriptions of the existence of these six species are as follows:

- Florida panther (*Felis concolorcoryi*): The existence of the Florida panther has not been confirmed in Louisiana recently (Taylor and Hoenke, 1993). Further, the large expanses of wilderness area needed for survival are not provided by the habitat on or surrounding the proposed CEC site.

- Eskimo curlew (*Numenius borealis*): The Eskimo curlew was once a common migrant in Louisiana. However, its presence in the State has not been confirmed since 1889 (Lowery, 1974). Only eight members of this species have been recorded on the range since 1959 (Nichols, 1990).

- Bachman's warbler (*Vermivora bachmanii*): The Bachman's warbler has been verified in Louisiana less than 12 times since 1889 (Lowery, 1974), although there have been

several unconfirmed sightings elsewhere in the State (Nichols, 1990). Most authorities agree that if the Bachman's warbler still exists, it is probably limited to locations in South Carolina (Nichols, 1990).

- Ivory-billed woodpecker (*Campephilus principalis*): The ivory-billed woodpecker is probably extinct across its entire range (Nichols, 1990). If it does exist, it is believed to require extensive mature stands of lowland hardwood forest that have not been disturbed by cutting. This condition does not exist at the CEC site.

- Red-cockaded woodpecker (*Picoides borealis*): The Red-cockaded woodpecker requires open stands of mature pines with a minimum age of 60 years (Parker and Dixon, 1980). Pine stands of this age do not exist on the CEC site because of recent and historical timbering on the property.

- Bald eagle (*Haliaeetus leucocephalus*): Inland, the bald eagle typically inhabits areas along freshwater lakes and rivers. There are many records of this species throughout Louisiana, including all areas in northern Louisiana where large lakes are present. The bald eagle may inhabit Lake Claiborne, located approximately 8 km (5 miles) south of the CEC site, although its existence there has not been recorded by the LNHP (Martin, 1990 and Lester, 1992). It is considered unlikely that the bald eagle would use the site due to a lack of appropriate habitat (i.e., large water bodies) on the site. Possibly, the species is transient in the site area, given the close proximity of the site to a potentially suitable habitat at Lake Claiborne.

In the absence of endangered or threatened species that inhabit the site or that use the site to any significant degree, the important wildlife species at the site are selected based upon their recreational or commercial value (NRC, 1975a). Table 3.35 lists the recreationally or commercially important wildlife species potentially present on the proposed CEC site.

Of these species, white-tailed deer and rabbit are the principal game species and raccoon is the principal furbearer in northwest Louisiana (Taylor and Hoenke, 1993). Therefore, these three species have been selected as important species for the CEC site. The other listed species, less important recreationally or commercially in this portion of the State (Taylor and Hoenke, 1993), are not considered important species. No other wildlife species are considered important species for the site. Further endangered species consultation will not be required unless the scope or location of the proposed project is changed, or project construction has not been initiated within 1 year. If project construction has not been initiated within 1 year, followup consultation must be accomplished prior to making expenditures for construction. If the scope or location of the proposed work is changed, consultation must occur when such changes are made.

Table 3.35 Recreationally or Commercially Important Wildlife Species Potentially Present on the Proposed CEC Site (American Ornithologists' Union, 1983, and Taylor and Hoenke, 1993)

Game Species	Scientific Name
White-tailed Deer	*Odocoileus virginianus*
Eastern Cottontail	*Silvilagus floridanus*
Gray Squirrel	*Sciurus carolinensis*
Fox Squirrel	*Sciurus niger*
Wild Turkey	*Meleagris gallopavo*
Bobwhite Quail	*Colinus virginianus*
Mourning Dove	*Zenaidura macroura*
American Woodcock	*Scolopax minor*
Fur Animals	
Mink	*Mustela vison*
Raccoon	*Procyon lotor*
Beaver	*Castor canadensis*
Skunk	*Mephitis mephitis*
Opossum	*Didelphis marsupialis*
Nutria	*Nyocastor coypus*
Coyote	*Canis latraus*
Fox	*Urocyon cinereoargenteus*
Bobcat	*Lynx rufus*

3.5.2.5 Species-Environment Relationships for Important Species

The abundance and distribution of white-tailed deer, cottontail, and raccoon at the proposed site depend upon the interaction of these species with their environment. These interactions are defined by each species' habitat requirements, life history, and population dynamics. The species-environment relationships for the three important terrestrial wildlife species are described in the following sections.

3.5.2.5.1 White-tailed Deer (*Odocoileus virginianus*)

Habitat Requirements

The ideal habitat for White-tailed deer in the southeast coastal plain (including the CEC site area) may be large blocks of dense cover within forested areas having limited tree canopy cover (to ensure understory food production) and common sources of fresh water (Short, 1986).

Deer browse on a variety of woody deciduous plants and some coniferous plants. Loblolly pine/hardwood habitats, such as those at the CEC site, support a wide variety of plant

species used as forage by deer. The plant species used as food by deer in northwest Louisiana, along with the abundance of these species on the CEC site, are listed in Table 3.36.

Table 3.36 Plant Species Used as Food by Deer in Northwest Louisiana (Taylor and Hoenke, 1993)

Common Name	Scientific Name	Usage and Palatability[a]	Abundance at CEC Site[b]
Woody Sprouts and Young Trees			
American Beech	*Fagus grandifolia*	H-M	M-S
White Oak	*Quercus alba*	M-L	C-S
Southern Red Oak	*Quercus falcata*	M-L	D-S
Water Oak	*Quercus nigra*	M	C-S
Sweetbay	*Magnolia virginiana*	M	S
Blue Beech	*Carpinus caroliniana*	H-M	C-S
Red Maple	*Acer rubrum*	M	D-S
Smaller Trees and Shrubs			
Arrow-wood	*Viburnum dentatum*	H	M-S
Cherry	*Prunus serotina*	H-M	M-S
Dogwood	*Cornus florida*	U	M-S
Hawthorn, Parsley	*Crataegus marshallii*	U	S
Holly, Decidious	*Ilex decidua*	H	S
Farkleberry	*Vaccinum arboreum*	M	M-S
Wax myrtle	*Myrica cerifera*	M-R	C-S
Vines			
Blackberry/Dewberry	*Rubus spp.*	M-L	C-S
Smilax	*Smilax spp.*	H	M-S
Rattan	*Berchemia scandens*	H	M-S
Fruits			
Acorns	*Quercus spp.*	H	D-S
Blackberries/Dewberries	*Rubus spp.*	H	C-S

[a] H = palatability high; M = palatability medium; L = palatability low; H-L or H-M = indicates palatability varies as indicated at different times of the year; U = usage and palatability unknown.
[b] D = dominant; C = common; M = moderate; S = scattered.

Water availability does not appear to be a limiting factor for deer populations, given the presence of Bluegill Pond, Lake Avalyn, and a few small drainage ways at the site.

Estimates of adequate cover are less precise. Harlow (1984) lists swamps and dense honeysuckle (*Lonicera spp.*) thickets as suitable cover, for white-tailed deer. This cover may be available on the 110 hectares (272 acres) of the site that have been recently cut. However, the amount of cover will increase as the vegetative community of the recently timbered area develops, probably within 5 years.

Space requirements for deer are based on consideration of typical population densities and home range areas of deer as well as the carrying capacity of the habitat. Pine/hardwood habitats in northwest Louisiana could support one deer per 20 hectares (50 acres) (St. Amant, 1959). Based on this conservative estimate and assuming that all habitat on the LES property is suitable, the site could support a maximum of approximately 10 deer. Short (1986), on the other hand, estimates that at least 100 acres/one deer of contiguous habitat is required before white-tailed deer will live and reproduce in an area. Using this assumption, the CEC site could support approximately five deer.

White-tailed deer typically reach sexual maturity at 18 months, although some females may mate as yearlings (DeGraaf, 1987). The breeding season is approximately November through February, and the gestation period is 6½ months (Burt, 1976). Average litter size is two young per female per year. Fecundity rapidly increases from 18 months to 3 years of age, then levels off between 3 and 6 years of age (Begon, 1986). Young typically stay with their mothers for about a year.

Population Dynamics

White-tailed deer are a gregarious species and usually travel in small groups. During the summer and fall, family groups consisting of a doe and her fawns are common. Yearlings sometimes join these family groups in late fall. In winter, groups of 25 deer or more are common (Burt, 1976).

3.5.2.5.2 Eastern Cottontail (*Silvilagus floridanus*)

Habitat Requirements

Eastern cottontails are found in a wide variety of disturbed, successional, and transitional habitats which are often characterized as bunch-type perennial grasses with an abundance of well-distributed escape sites (Chapman, 1982). This species avoids dense woodlands. Rabbits are herbivores which use a wide variety of plants as food, making food of little or no consequence in their distribution (St. Amant, 1959). Conversely, because of the cottontail's susceptibility to avian and mammalian predators, cover is one of the most important habitat requirements for this species and may be a limiting factor in rabbit population growth. Cover often consists of dense, thorny, low-growing, woody perennials; however, brush piles in cut-over woodlands also provide shelter (Chapman, 1982). Given these general cover-type requirements, it is probable that the vegetative communities of the

CEC site provide adequate cover to support cottontail populations. The recent timbering at the site has probably increased the amount of available cover for this species.

If cover and other habitat requirements are met, local populations of cottontails may occasionally reach densities of eight animals per acre, but typical population densities are considerably lower (Chapman, 1982).

In Louisiana, cottontails breed every month of the year; peak breeding season begins in February and continues through September (St. Amant, 1959). Individual females produce up to 4 or more litters per year, and the total number of young produced per year per female is 25 or more (St. Amant, 1959). However, mortality among the young is high and the number of offspring reaching maturity probably does not exceed 20 percent (St. Amant, 1959). Young disperse at about 7 weeks of age and reach sexual maturity in 2 to 3 months (DeGraaf, 1987). Most females breed the first spring following birth (DeGraaf, 1987).

Population Dynamics

Age and breeding status of individual members control, to a large degree, cottontail population. Cottontails do not maintain territories. Home ranges of different age and sex classes overlap broadly during much of the year, particularly during the late fall and winter when cottontails tend to concentrate in areas offering the best combination of food and escape cover (DeGraaf, 1987).

3.5.2.5.3 Raccoon (*Procyon lotor*)

Habitat Requirements

Raccoons inhabit wooded areas interrupted by fields and water courses. This species is relatively scarce in dry upland woodlands, especially where pines are mixed with hardwoods and in southern pine forests (Kaufmann, 1982). Raccoons at the CEC site are probably limited to areas near Bluegill Pond and Lake Avalyn and in bottomlands along drainage ways.

Raccoons are omnivorous, opportunistic feeders. Animal matter is their major food item in spring and early summer, and vegetative matter is their primary food item at other times of the year (DeGraaf, 1987). Fleshy fruits, including wild grapes (*Vitis spp.*), cherries (*Prunus spp.*), and persimmons (*Diospyros spp.*) are important summer foods; acorns (*Quercus spp.*) and other nuts are important foods in the fall and winter (Kaufmann, 1982). Each of these food items is found at the CEC site.

Population Dynamics

Raccoon mating generally occurs from January to March, peaking in February (Kaufmann, 1982). Gestation is 9 weeks and birth occurs in April or May (Burt, 1976). A female

produces one litter per year, ranging in size between two and five young (DeGraaf, 1987). Approximately one-half of the females breed as yearlings; the others breed when they are 2 years old (DeGraaf, 1987). Young stay with their mothers until the fall (Burt, 1976). The most common social group for raccoons consists of a mother and her young of the year (Kaufmann, 1982). These animals do not appear to be territorial, and individual home ranges overlap broadly at times. Individual home ranges generally are in the range of 40 to 100 hectares (100 to 250 acres). Population densities range from 1 to 5 raccoons per 40 hectares (100 acres) (Kaufmann, 1982).

3.5.2.6 Pre-Existing Environmental Stresses

Timbering operations represent the primary pre-existing environmental stress on the wildlife community of the site. As discussed earlier, timbering alters the composition, structure, and function of the plant community. This in turn alters the composition, structure, and function of the associated wildlife community.

The most probable result of the clearcutting on the site is a shift from species associated with mature forests to those associated with scrub-shrub or young forest habitats. For example, the populations of forest interior bird species such as hairy woodpecker (*Picoides villosus*), yellow-billed cuckoo (*Coccyzus americanus*), acadian flycatcher (*Empidonax virescens*), and red-eyed vireo (*Vireo olivaceus*) probably have decreased as a result of the recent cutting; whereas those of forest edge-associated species, such as rufous-sided towhee (*Pipilo erythrophthalmus*), song sparrow (*Melospiza melodia*), and American goldfinch (*Carduelis tristis*) probably have increased. Mammals such as gray fox (which prefer mature, open forests) and gray squirrel (which prefer forests with mature nut trees) probably will be negatively affected. Conversely, cottontail populations at the site may have increased as a result of the recent clearcutting that created open areas with heavy brush. White-tailed deer populations probably will benefit from increased food in the clearcut areas after cover is re-established. Raccoons, who are not typically found in dense forests, also may benefit from the recent clearcutting.

Any changes in the wildlife community as a result of the clearcutting are likely to be short-term; species distribution and abundance are likely to return to previous levels as the vegetative communities of the site approach pretimbering conditions. Thus, it is possible that populations of the important species at the site will increase over the next several years following clearcutting, but eventually will decrease as the forest matures.

No other environmental stress on the terrestrial wildlife community (e.g., disease, chemical pollutants) has been suspected at the proposed CEC site.

3.5.3 Aquatic Communities

Aquatic habitat on the LES property consists of Lake Avalyn in the northeast corner, Bluegill Pond in the southwest corner, small streams, and a small wetland area near the

Lake Avalyn overflow discharge point. Both Lake Avalyn and Bluegill Pond are dammed and receive drainage from the surrounding areas.

Onsite surveys were conducted in January (Davis, 1990b) and May of 1990 (Davis, 1990a) to identify the aquatic organisms in Bluegill Pond and Lake Avalyn. This information has been used in conjunction with information on species habitat preferences and species found within the region to identify species that may inhabit the CEC site. The plant and animal components of the aquatic environments at the site are discussed below.

3.5.3.1 Plants

The phytoplankton of both Bluegill Pond and Lake Avalyn is dominated by yellow-green algae (*Chrysophyta*). Blooms of Synura and Dinobryon, species of yellow-green algae, comprised 91 percent of the phytoplankton in Lake Avalyn and 82 percent of the phytoplankton in Bluegill Pond. Synura grows well under ice; the abundance of this algae during the January survey may have resulted from the iced-over conditions in both the pond and the lake for 2 to 3 weeks in December 1989.

The macrophytic community of Lake Avalyn is much more abundant and diverse than that in Bluegill Pond. Smartweed (*Polygonum sp.*) was the only macrophyte found in the water of Bluegill Pond, whereas 11 species of macrophytes were identified in the water of Lake Avalyn. Horned pondweed (*Zannichellia palustris*) was the most common macrophyte in all surveyed areas of Lake Avalyn; smartweed, marsh purslane (*Ludwigia palustris*), and rush (*Juncus repens*) were locally common in selected areas of the lake.

Because the phytoplankton and macrophyte communities of the small onsite streams and the small wetland area near the Lake Avalyn overflow discharge point were not sampled, the species composition of the aquatic plant communities in these areas is not known. However, many of the same species of macrophytes that were found in Lake Avalyn could occur in these other aquatic habitats, particularly in the small wetland area. The phytoplankton communities in these areas may be reduced from those observed in the pond and lake because phytoplankton in lotic (running water) systems are generally less abundant and less stable than those in lentic (still water) environments (Goertz, 1990b).

3.5.3.2 Animals

The fish species identified during the onsite aquatic survey, as well as by the Louisiana Department of Wildlife and Fisheries, were typical of small warm-water ponds in northwest Louisiana (Taylor and Hoenke, 1993). Some of the fish species listed (i.e., spotted bass [*Micropterus punctualatus*] and alligator gar [*Atractosteus spatula*]) are more likely to inhabit larger lakes or streams. Although they potentially may occur at the CEC site, they are unlikely.

Invertebrates consist of zooplankton that live in the water column and benthic (bottom-dwelling) species. The zooplankton communities in both Bluegill Pond and Lake Avalyn were smaller and less diversified compared to those in similar waters of Louisiana. The lower densities of some species of zooplankton may be attributed to the time of sampling (winter morning). Protozoans, capepods, cladoceraus, and rotatarians form the dominant groups of zooplankton in Bluegill Pond and Lake Avalyn (Davis, 1990b). The benthic species collected were typical of those found in relatively undisturbed environments. Mayflies and dragonfly larvae were identified, as well as catfish, caddisflies, and snails. Invertebrates in onsite streams and in the small wetland were not sampled. Probable invertebrates in these environments include copepods, crayfish, and insects.

Fish species belonging to the families *Centrarchidae* (e.g., sunfish, bass, crappie) and *Ictaluridae* (catfish) tend to dominate small impoundments, such as those on the CEC site. Of the 11 species of fish that were identified in Bluegill Pond or Lake Avalyn, 5 were centrarchids; no other family had more than 1 species represented in the sampled waters. No catfish were collected from either Bluegill Pond or Lake Avalyn, but this could be because the deeper waters that catfish prefer during winter months were not sampled during the onsite survey.

The onsite streams and small wetland area were not sampled for fish. However, common fish in these aquatic environments are probably limited to smaller species such as mosquitofish (*Gambusia affinis*) and darters (*Etheostoma gracile*).

3.5.3.3 Important Aquatic Species

No Federally-threatened or endangered aquatic species inhabit the CEC site area (Nichols, 1990; Martin, 1990). In the absence of endangered or threatened species at the site, the important aquatic species at the site were selected based on their recreational value. Important game fish in northwest Louisiana ponds and lakes, including those located at the CEC site, include bass, crappie, catfish, and sunfish (Taylor and Hoenke, 1993). Each of these species groups is considered important at the site. For the purposes of this document, the representative species from the bass genus is the largemouth bass (*Micropterus salmoides*), the genus crappie is represented by the white crappie (*Pomoxis annularis*), catfish are represented by the channel catfish (*Ictalurus punctatus*), and the sunfish genus is represented by the bluegill (*Lepomis macrochirus*). Bluegill are known to be in both Bluegill Pond and Lake Avalyn. Although other species have not been observed, they could be present in these waters.

3.5.3.4 Species-Environment Relationships for Important Species

Species-environment relationships for the four important fish species at the CEC site are described in the following sections.

3.5.3.4.1 Largemouth Bass (*Micropterus salmoides*)

Habitat Requirements

Lakes are the preferred habitat of largemouth bass, although they also live in large slow-moving rivers. The optimal habitat would consist of lakes with extensive shallow areas to support submerged vegetation, yet deep enough to successfully overwinter bass. Flooded vegetation is a necessary habitat for fry. Both Bluegill Pond and Lake Avalyn are deep enough to overwinter bass. However, Lake Avalyn may provide better bass habitat due to a greater amount of flooded vegetation. Food preferences vary with lifestage: adult largemouth bass feed primarily on fish and crayfish, juveniles consume mostly insects, and fry feed mainly on microcrustaceans and small insects (Stuber et al., 1982b).

Largemouth bass are sensitive to changes in water quality parameters. Growth of largemouth bass is reduced if dissolved oxygen levels are less than 8 milligrams per liter (mg/l); distress may be evident at levels of 5 mg/l. Largemouth bass also are intolerant of suspended solids and sediment. Moderate to high levels of suspended solids (25 ppm or greater) may interfere with reproductive processes and reduce growth. Largemouth bass require a pH between 5 and 10 for successful reproduction, although the species can tolerate short-term exposures to pH levels of 3.9 to 10.5 (Stuber et al., 1982b).

Population Dynamics

Largemouth bass are a long-lived species, and largemouth bass up to 15 years of age have been recorded. Largemouth bass mature and spawn as early as their second year (age I) in southern portions of their range. Spawning generally begins in the spring and occurs in low-velocity [<0.30 m/sec (<1 ft/sec)] waters at depths between 0.15 to 7.6 m (.5 to 25 ft). The optimal temperature for spawning and incubation is approximately 20° C (68° F) (Stuber et al., 1982b).

3.5.3.4.2 White Crappie (*Pomoxis annularis*)

Habitat Requirements

White crappie inhabit freshwater lakes as well as low-velocity pools and overflow areas of larger rivers. The species thrives in lakes and reservoirs greater than 2 hectares (5 acres) in size. Thus, white crappie are likely to be more abundant in Lake Avalyn than in Bluegill Pond. The availability and quality of both food and cover are important habitat characteristics that influence the distribution of white crappie within a given aquatic environment, however, the quality and quantity of food may be one of the most important limiting factors. Adult and juvenile white crappie forage in open water and feed almost exclusively on fish. Fry first feed on copepods, rotifers, and algae, switch to a variety of zooplankton as they grow larger, and finally switch to insects as they mature (Edwards, 1982).

White crappie can tolerate dissolved oxygen concentrations as low as 3.3 mg/l, but a concentration of 5 mg/l is probably the lowest limit at which optimal growth and survival occur. White crappie prefer moderately turbid waters, but the best growth occurs in clearer waters, i.e., <50 Jackson Turbidity Unit (JTU). Black crappie (*Pomoxis nigromaculatus*), however, usually predominate in clear waters where they coexist with white crappie (Edwards, 1982).

Population Dynamics

White crappie have an average lifespan of 7 to 9 years. Individuals generally mature between their second and fourth years (ages I to II). Spawning occurs during March to July when water temperatures reach 13° C to 14° C (55° F to 57° F); peak spawning occurs at water temperatures of 16° C to 20° C (61° F to 68° F). Nests are typically constructed on substrates of clay, dirt, or gravel near inundated vegetation (Edwards, 1982).

3.5.3.4.3 Channel Catfish (*Ictalurus punctatus*)

Habitat Requirements

Channel catfish occur over a broad range of habitats, but are most abundant in large rivers. In lake environments, channel catfish favor sand, gravel, or rubble substrates over shoals and deep, protected areas. Optimal lake habitat for channel catfish appears to be large, fertile, warm lakes with clear to moderate turbidities, and abundant cover of logs, boulders, and cavities. Diet varies with age class. Young-of-the-year catfish (age 0) feed predominantly on plankton and aquatic insects. Adult catfish are opportunistic feeders and are able to locate suitable food in a variety of habitats. Adult catfish feed on insects, detrital and plant material, crayfish, and mollusks (McMahon and Terrell, 1982).

Growth is greatest in clear waters with dissolved oxygen levels greater than 5 mg/l. Dissolved oxygen levels above 7 mg/l are optimal for survival and growth of channel catfish embryos and larvae (McMahon and Terrell, 1982).

Population Dynamics

Channel catfish are a long-lived species. Age at maturity is variable, but southern channel catfish generally mature in their sixth year (age V). Channel catfish spawn in late spring and early summer. Males build and guard nests in cavities, burrows, under rocks, and in other dark, secluded, protected sites (McMahon and Terrell, 1982).

3.5.3.4.4 Bluegill (*Lepomis macrochirus*)

Habitat Requirements

Bluegill inhabit clear, warm pools of streams, lakes, ponds, and sloughs; within these habitats, they usually inhabit shallow waters with vegetation (Niering, 1985). Optimal lake habitat is characterized by fertile waters with extensive littoral areas (≥20 percent of total lake surface area). Bluegills are opportunistic feeders and alter their diet according to food availability. Fry feed primarily on zooplankton and small insects. Juveniles and adults feed primarily on zooplankton, aquatic and terrestrial insects, and some plant material (Stuber et al., 1982a).

Optimal growth and reproduction occur in clear to moderately turbid waters. Bluegill can tolerate dissolved oxygen levels as low as <1 mg/l for short durations, but optimal levels are >5 mg/l. Optimal pH is in the range of 6.5 to 8.5 (McMahon and Terrell, 1982).

Population Dynamics

Bluegills generally live to between 1 and 4 years of age, although an age of 11 years has been recorded. Individuals generally mature in their second or third year (age I or II). Bluegills are repeat spawners, and the spawning may extend from spring through summer. Nests are built in quiet, shallow (1 to 3 m deep) waters (Stuber et al., 1982a).

3.5.3.5 Pre-Existing Environmental Stresses

Timbering operations represent the primary source of pre-existing stress on the aquatic communities at the CEC site. The clearcutting may have resulted in increased erosion in timbered areas, resulting in an increased sediment and nutrient load to both Bluegill Pond and Lake Avalyn. This can cause increased turbidity and siltation in these aquatic environments. The potential for increased turbidity and siltation is greatest for Bluegill Pond, as the clearcutting in the surrounding area was more extensive and severe than in the area surrounding Lake Avalyn. A comparison of turbidity measurements collected from Bluegill Pond prior to the clearcutting activities in January 1990 (Davis, 1990b), and after clearcutting in May 1990 (Davis, 1990a), suggests that the pond has been altered by the timbering operations. Turbidity in January was approximately 8 JTU, whereas in May it increased to 48 JTU. Turbidity in Lake Avalyn, however, remained essentially unchanged.

Increased turbidity and siltation can have varying effects on the growth, reproduction, and survival of the important aquatic species at the CEC site. For example, moderate to high levels of suspended solids may interfere with reproduction and growth in largemouth bass, whereas moderate turbidity levels are favored by white crappie. Bluegills reproduce and grow optimally in clear and moderately turbid waters, and thus may be less affected by small changes in turbidity. In general, increased siltation may result in a decreased number of fish spawning sites, particularly for nest building species such as those selected as important for

this evaluation. An increase in organic matter in Bluegill Pond or Lake Avalyn could result in increased biological oxygen demand as bacteria use oxygen while they decompose the organic matter. This, in turn, results in lowered dissolved oxygen concentrations within the water column and decreases the number of gilled species. Average dissolved oxygen levels were substantially lower in post-timbering (May 1990) samples (Davis, 1990a) than in pre-timbering (January 1990) samples (Davis, 1990b) in both Bluegill Pond (3.1 vs. 9.0 mg/l) and Lake Avalyn (2.8 vs. 8.3 mg/l). This decrease may have resulted from increased organic load to these waters because of timbering. However, the lower oxygen levels could reflect the higher level of biological activity typical of these ponds during warmer months of the year, or may result from higher temperatures alone.

3.6 Socioeconomic and Local Community Characteristics and Services

The following sections describe the social, economic, and community characteristics of Claiborne Parish. The town of Homer has been emphasized due to its proximity to the proposed facility location. Forest Grove and Center Springs are clusters of homes located near the Forest Grove Church, to the south of the CEC site, and the Center Springs Church, to the north of the site. They are not defined political subdivisions and do not have distinct boundaries, elected officials, law enforcement, or tax authority. In almost all cases, impacts are not limited to these two nearby communities; thus, they are not singled out. Socioeconomic impacts will be distributed throughout Claiborne Parish and beyond.

3.6.1 Social Activities and Organizations

There are 37 social clubs and organizations in the town of Homer; these groups are listed in Table 3.37. In addition, Claiborne Parish supports 52 Protestant churches and 1 Catholic church.

3.6.2 Public Services

3.6.2.1 General Education

There are 9 local public primary and secondary educational facilities within a 20-mile radius of the LES site, with an overall enrollment of 2,932 students (Speer, 1992). Table 3.38 details the location of public educational facilities, enrollment, number of faculty members, and student/teacher ratios. There are also two privately supported secondary schools in the area; Claiborne Academy, north of Homer and Mt. Olive Christian School near Athens.

Expansion of the Claiborne Parish School system is not currently planned, nevertheless, the Parish Schools could absorb an influx of up to 300 new students without disruption (Speer, 1992). One hundred sixty-nine students graduated during the 1991-1992 academic year.

Louisiana Technical University, the closest university to the proposed site, is located in Ruston, approximately 50 km (30 miles) from the site. The University has a total

Table 3.37 Social Groups in Homer, Louisiana (Based on Homer Chamber of Commerce, 1991)

Club/Organization	
American Legion	Friends of the Library
American Legion Auxiliary	Homer Chamber of Commerce
Boy Scout Troops	Homer Flower & Garden Club
Business Women's Extension Club	Homer Golf Club
Citizens Against Nuclear Trash (CANT)	Homer Lions Club
Claiborne Bass Busters	Homer-Mayfield School Reunion
Claiborne Education Association	Homer Memorial Hospital Guild
Claiborne Parish Bus Operators Association	Homer Public Support Group
Claiborne Parish Chapter Louisiana State Medical Society Auxiliary	Homer Town Council
Claiborne Parish Industrial Development Foundation	Ladies Day Weekly Country Club
Claiborne Parish Ministerial Alliance	Lake Claiborne Promotional Association
Criterion Club	Martha Chapter #79 O.E.S.
Daughters of the American Revolution	Masonic Lodge
Delta Kappa Gamma	Mildred Bevill Music Club
Eastern Star	NAACP Claiborne Parish
Esther Grand Chapter O.E.S.	Retired Teachers of Claiborne Parish
Extension Homemakers	Succoth Lodge #80
Forest Grove Hunting Club	White Rose Club
	Women's Department Club

enrollment of 10,380. The faculty consists of 398 full-time and 29 part-time professors. Degrees offered are Associates, Bachelors of Arts and Science (BA and BS), Master of Science (MS), and Doctor of Philosophy (Ph.D.) in a range of subjects (Peterson's Guides, 1992).

Grambling State University, located approximately 50 km (31 miles) southeast of Homer, has a total enrollment of 6,485. The faculty consists of 262 full-time and 20 part-time professors. The University offers Associate and Bachelor of Arts and Science (B.A. and B.S.) degrees (Peterson's Guide, 1992).

Table 3.38 Claiborne Parish School System Breakdown (Speer, 1992)

		Capacity		
School and Location	Grade Level	Number of Students	Number of Faculty	Student/ Teacher Ratio
Athens High School Athens, LA	K-12	237	19	12:1
Haynesville Elementary School Haynesville, LA	K-4	357	29	12:1
Haynesville Jr. High School Haynesville, LA	5-8	310	18	17:1
Haynesville High School Haynesville, LA	9-12	239	18	13:1
Homer Elementary School Homer, LA	K-4	567	31	18:1
Homer Jr. High School Homer, LA	5-8	434	26	17:1
Homer High School Homer, LA	9-12	280	24	12:1
Pineview High School Lisbon, LA	K-12	218	20	11:1
Summerfield High School Summerfield, LA	K-12	290	20	14:1

Northeast Louisiana University is located in Monroe, approximately 100 km (60 miles) from Homer. There are 11,189 students enrolled, and the faculty consists of 428 full-time and 56 part-time professors. The University offers Associate and Bachelor of Arts and Science (BA and BS) degrees (Peterson's Guide, 1992).

In addition, there are six college campuses within 88 km (55 miles) of Homer:

1. South Arkansas University, Magnolia, AR
2. South Arkansas University, El Dorado, AR
3. Southern University of Shreveport
4. Louisiana State University, Shreveport Campus
5. Centenary College, Shreveport
6. Bossier Community College, Bossier City

3.6.2.2 Public Safety

Fire protection in Homer is provided by the Volunteer Fire Department. Homer maintains five firetrucks and one emergency unit. Haynesville fire protection consists of 20 volunteer firefighters and three firetrucks. The town of Lisbon has a Volunteer Fire Department consisting of 40 firefighters, four pumping trucks, and four tank trucks. Table 3.39 provides a description of regional police and fire departments.

Table 3.39 Local and Regional Police and Fire Protection (Ciccarelli, 1994; Pueh, 1994; Featherston, 1992; Moreland, 1992; and Walker, 1992)

Town/Parish	Total Police Officers	Sheriffs, Deputies, and Other Employees	Vehicles (Patrol and Unmarked Cars)	Firefighters	Firetrucks and Emergency Vehicles
Homer	9	-	4	26	6
Haynesville	7		4	20	3
Lisbon	-	-	-	40	8
Claiborne		21	14	-	-

The Claiborne Parish Sheriff's Office has a total of 21 employees, and maintains 10 patrol cars and 4 unmarked vehicles (Moreland, 1992; Ciccarelli, 1994). The number of employees has remained relatively constant since 1988, but is about to increase slightly when it hires two more employees this year (Ciccarelli, 1994 and U.S. Department of Justice, 1993). In addition to the Parish's resources, the Homer Police Department has nine full-time officers and four police vehicles (Pueh, 1994). The Haynesville Police Department has seven full-time officers and four vehicles.

According to local police, the area experiences drug-related crime, including "crack" cocaine dealing, and drug-related burglaries, thefts, and robberies. During periods of higher-than-average crime, police resources (almost unchanged since 1988) appear to come under strain. Budgetary constraints have imposed hiring freezes, and have even resulted in the dismissal of police employees (Walker, 1992). The hiring freeze, however, was lifted this year and two officers were added to the police force (Mills, 1994). The combination of fluctuating and/or rising crime rates and limited resources should not be viewed as unusual, but rather as part of a nationwide problem. Table 3.40 compares reported offenses in the Parish to those in rural communities across the country. The table shows that although the crime rate in Claiborne parish is no higher than average, wide fluctuations do occur (e.g., there were five murders and two forcible rapes in 1991, but none in 1992). The sheriff of Claiborne Parish, who has law enforcement jurisdiction over the CEC site area, does not believe that there are any particular crime problems in his jurisdiction. He believes that the department could handle any changes in crime patterns associated with the CEC (Oakes, 1993).

Table 3.40 Crime Types in Claiborne Parish vs U.S. Rural County Average, 1991-1992 (U.S. Department of Justice, 1993 and Ciccarelli, 1994)

Type of Crime	Total Number of Offenses Known				Offenses per 100,000 Inhabitants			
	Claiborne Parish		U.S. Rural County Total [b]		Claiborne Parish		U.S. Rural County Average [b]	
	1991	1992	1991	1992	1991	1992	1991	1992
Murder and Non-Negligent Manslaughter	5	0	1,363	1,249	28.7	0.0	5.5	5.1
Forcible Rape	2	0	5,734	6,255	11.5	0.0	23.3	25.4
Robbery	3	2	3,766	3,824	17.2	11.5	15.3	15.5
Aggravated Assault	27	31	38,679	41,107	155.1	178.1	157.1	167.0
Burglary	119	106	175,952	168,275	683.7	609.0	714.7	683.5
Larceny-Theft	177	200	262,930	262,257	1,016.9	1,149.1	1,068.0	1,065.3
Motor Vehicle Theft	8	11	29,534	27,844	46.0	63.2	120.0	113.1
Arson	0	1	4,510	4,337	0.0	5.7	18.3	17.6
Total Number of Violent and Property Crimes [a]	341	351	522,468	515,148	1,959.2	2,016.7	2,122.2	2,092.5

[a] Includes arson.
[b] Total Population is 24,619,000

3.6.2.3 Health Services/Facilities

There are two health clinics and two physicians with private practices in Homer. The Claiborne Family Medical Clinic is a modern health facility with a staff of four physicians.

Homer Memorial Hospital is staffed with 175 employees, 6 family practitioners, and 3 specialists, part-time, as needed. The hospital has 57 beds and the capability of handling 30 to 40 patients over the daily average. The North Claiborne Hospital in Haynesville was closed in 1991. There are no future plans to reopen this hospital (Toggles, 1992). The Homer Hospital now serves the entire Claiborne Parish.

Five dentists have practices in Homer. Two nursing homes are located in the area, Claiborne Manor and Presbyterian Village (Toggles, 1992).

3.6.2.4 Housing

Local records are not maintained on the amount of housing available, prices, or vacancy rates. The following information is derived from a review of the weekly journals published in the Homer-Haynesville area for the time periods April 25, 1991, and May 14, 1991, from Johnson Real Estate located in Homer.

Homes available for purchase in Homer and surrounding regions of the proposed site consisted of approximately 57 single-family homes and four mobile homes (The Advertiser, 1991 and The Guardian Journal, 1991). The price range for these homes was stated to be $15,000 to $100,000, with an average of $57,500 based on these values. Home prices, after declining in 1991, have rebounded to some extent; however, prices are still below the peak they reached in 1989. More homes and apartments are available for rent than in 1991 (Johnson, 1992).

In 1990, housing statistics showed a total of 7,513 units in Claiborne Parish. Of these, 6,065 were occupied. Seventy-five percent, or 4,575, were owner-occupied. The remaining 25 percent, or 1,490, were occupied by tenants. The occupancy rate at that time was 81 percent (Department of Commerce 1992a and 1992b). Percent change in housing stock from 1970 to 1980 was 19.3; from 1980 to 1990, this change was 6.7 percent. Between 1980 and 1986, seven building permits were issued for private homes in Claiborne Parish (Department of Commerce, 1988).

3.6.2.5 Recreational Facilities

Lake Claiborne is located approximately 6.4 km (4 miles) south of the town of Homer and approximately 8 km (5 miles) southwest of the proposed facility site. The State of Louisiana maintains Lake Claiborne State Park at the southern end of the lake. The State park consists of over 242 hectares (600 acres), providing facilities for 87 campsites, 100 picnic

sites with tables and grills, hiking trails, boating, swimming, and fishing. The park also maintains a public boathouse and launching points, rest rooms, and a concession stand. During Fiscal Year 1991-92, 44,024 people visited the park (Kent, 1993).

The Kisatchie National Forest is located approximately 8 km (5 miles) north of the proposed facility location. The Dogwood Trail provides access to the forest, Mt. Zion Cemetery, the Antioch Fire Line, and a hiking trail to the State Line.

Kisatchie National Forest-Carney Lake is located approximately 15 miles north of the proposed site. Both of these forests have sites available for hiking, camping, fishing, swimming, boating (Carney Lake), and hunting. No records are available of the number of national forest visitors. Nevertheless, the Kisatchie National Forest Carney Lake is a popular area and generally maintains a high level of visitor use. The Donogue State Park was dedicated in 1933 as a memorial to Governor Donogue of Arkansas. A National Geological Survey Point and a monument to Huey P. Long are located in this park.

Claiborne Parish is listed in "Field and Stream" magazine as one of the top parishes for hunting and fishing in Louisiana. The Claiborne Parish economy is based in part on its natural resources in terms of oil production, logging, and outdoor sports. A filming commission has been formed in Haynesville to market the natural features of the Homer-Haynesville region (Ruston Daily Leader, 1990 and 1991).

There are three hunting lodges in the Homer-Haynesville area. Southern Expeditions, located in Haynesville, is situated on 525 hectares (1,300 acres) of woodland. The lodge offers deer and quail hunting. The Burnham Plantation Bed and Breakfast, also located in Haynesville, is an 1890s victorian house with a 6.5-hectare (16-acre) pond stocked for fishing. The Tall Timbers Bed and Breakfast and Hunting Lodge located in Homer, similar to Southern Expeditions, also offers fishing.

3.6.2.6 Transportation

Roads. There are three State roads and one Federal highway located within 8 km (5 miles) of the proposed facility location. The road systems in the area of the proposed facility location are Parish Road 39; State Roads 2, 9, 39, and 149; and Federal Highway 79. Parish Road 39 provides access to the CEC by linking it to State Road 9 (to the north), and to State Road 2 (to the south). Table 3.41 provides a description of traffic volume on these transportation routes. Parish Road 39 has the least amount of traffic.

The traffic counts taken at sites determined by the State Department of Transportation represent the average traffic flow. The local State of Louisiana Department of Transportation and Development Office has not detected any significant traffic volume shift since 1991, when the last precise measurement was taken (Reed, 1992). Furthermore, no road construction has taken place in or near the vicinity of the proposed CEC site since 1991 (Lee, 1992).

Table 3.41 Traffic Volume for Impacted Road Systems
(Louisiana State Department of Transportation and Development, 1990)

Road	Traffic Volume per Day
State Road 9	
- 3rd and 4th Streets	6,540
- City Limits	2,760
- S. Main and 52nd Streets	10,200
State Road 2	
- U.S. 79 and 9	2,130
- East of 9	1,770
- West of U.S. 79	690
State Road 149	
- South of the City Limit	1,570
- 3rd and Main	1,830
Federal Highway 79	
- South of City Limit and 9	6,070
- North of 3rd Street	9,380
- North City Limit	3,160
Parish Road 39	
- South of State Road 9 (halfway down to State Road 2)	190
- North of State Road 2 (halfway up to State Road 9)	210

Rail Services. The Louisiana and Northwest (L&NW) Railroad is located approximately 13 km (8 miles) southwest of the proposed facility location. The L&NW is used for freight transport and has a maximum track capacity of 143,000 gross kg (315,000 gross pounds) for car and lading. The only train scheduled per day travels in each direction every other day. Each train averages 18 cars (White, 1992).

Air Services. The Homer Aviation Airport is located approximately 8 km (5 miles) from the proposed facility. The airport's only runway, originally intended to measure 1,200 m (4,000 ft), was built 980 m (3,200 ft) long. The State and local governments plan to extend the length of the runway to its proposed length sometime in the near future. No scheduled flights run from or to the airport. Privately-owned planes are the primary users of this airport; however, there are also State and other official flights related to the Wade Correctional Facility. The airport maintains one fuel supply and two hangars used for repairs and storage (Nogle, 1992).

The town of Haynesville also has a small airport used for privately-owned planes. There is only one runway, 910 m (3000 ft) long, and no hangars. There are no scheduled flights from or to the airport, and no need for full-time staff (Crocker, 1992).

The Monroe Airport, approximately 97 km (60 miles) from the proposed site, is a minor commercial airport receiving L-Express, Northwest Airlink, American Eagle, and Delta flights. The airport consists of three runways measuring 2,288, 1,524, and 1,524 m (7,507, 5,000, and 5,001 ft). There is a control tower, on-field fuel supply, and repair facilities.

The Ruston Airport, located 72 km (45 miles) from the proposed site, has no commercial flights and maintains one 1,200-m (4,000-ft) runway, eight hangars, an on-field fuel supply, and minor repair facilities.

El Dorado Airport, located in El Dorado, Arkansas, approximately 48 km (30 miles) from the proposed site, receives one commercial airline: Lone Star Airline. The airport consists of three runways; one at 2,000 m (6,600 ft), and two at 1,200 m (4,000 ft). The airport also maintains 14 hangars, an on-field fuel supply, and repair facilities (Herrell, 1993).

The nearest major commercial carrier airport is the Shreveport Regional Airport located in Shreveport, Louisiana (Homer Chamber of Commerce, 1991).

Public Transportation. Homer does not maintain a city bus system. Three interstate bus carriers schedule stops in Homer: Trailways Bus Line, Continental, and Greyhound. No taxicabs operate in Homer.

Postal Services. Interstate common carrier services are Morgan Time DC, Steve D. Thompson, and Overnight Transportation. Special parcel services are provided by Airborne, Emery, Federal Express, Purolator, and the United Parcel Service (Homer Chamber of Commerce, 1991).

3.6.2.7 Utilities and Communications

Electric. Electrical power is supplied to Claiborne Parish by the Cajun Electric Power Cooperative, Inc. The local distributors are the Claiborne Electric Cooperative, Inc., and Louisiana Power and Light (LP&L).

Natural Gas and Oil. Natural gas for Claiborne Parish is provided by the Arkansas-Louisiana Gas Company. The local distributor is the Louisiana Gas Service Company.

Water and Sewage. The current water supply in Homer and Haynesville is abundant. Two main wells provide all of Homer's water requirements; one has a 2,270 liters per minute (lpm) or 600 gallons per minute (gpm) capacity, and the second handles 760 lpm (200 gpm) (Moek, 1994). Normally, the larger capacity well supplies the entire town and the smaller well is kept as an emergency standby source. Two new wells have been drilled and will be online in early 1995. The first new well has a capacity of 2,650 lpm (700 gpm); the second, which replaces an older failed well, has a capacity of 1,890 lpm (500 gpm). Water from these two wells will be piped to a water treatment plant, now under construction, that will treat 3,410 lpm (900 gpm) and store any additional flow in underground storage tanks. All

of the wells access the Sparta Aquifer, which would also feed CEC's water supply wells. A small number of homes in the vicinity of the site obtain their water supply directly through their own wells, which tap shallower water beds. Peak consumption for Homer and Haynesville is 3.8 and 3.0 million liters per day (or 1.0 and 0.8 mgpd), respectively. Water storage capacity for Homer and surroundings is 7.6 million liters (2.0 million gallons), and for Haynesville capacity is 2 million liters (0.5 million gallons). Although Lake Claiborne could be another source of water, the current and foreseeable cost of treating the water would be prohibitive *vis-a-vis* the relatively low volume demanded (Moek, 1992). The Sparta Aquifer's water level has dropped only slightly over the years; it is expected to meet water demand for many years (Moek, 1994). However, if future water demand exceeds the Sparta Aquifer's supply, Lake Claiborne could become an important source. The Homer water and sewer departments are funded solely by revenues from customers based on usage. These departments service approximately 1,781 customer accounts (LES, 1992h).

The Sanitary Sewage System for the town of Homer provides for the entire community. The system capacity is 5.07 million liters per day (1.34 mgpd), and the present load is 2.9 million liters per day (0.80 mgpd). The city does maintain a storm sewer system. Solid waste/garbage is disposed locally in a sanitary landfill (LES, 1994a).

Communications. Homer receives two weekly newspapers: "The Haynesville News" and "The Guardian Journal." No radio or television programs broadcast locally. Several regional radio stations can be received in Homer. Five television channels can be received without cable, which provides an additional 18 channels. South Central Bell and Century provide telephone service. Telegraph service is provided by Western Union (Homer Chamber of Commerce, 1991).

3.7 Demography

3.7.1 Population

The population of Claiborne Parish has been stable for the past 20 years. For the years 1970, 1980, and 1990, the population of the Parish was 17,024, 17,095, and 17,405, respectively (Department of Commerce, 1992b). The local labor pool available to CEC includes seven Louisiana parishes: Bienville, Bossier, Caddo, Claiborne, Lincoln, Union, and Webster. Detailed demographic information is provided on these parishes (LES, 1994a). The broad labor pool (Figure 3.24) includes these seven parishes, plus eight additional Louisiana parishes (Caldwell, De Soto, Jackson, Morehouse, Ouachita, Red River, Richland, and Winn) and nine Arkansas counties (Ashley, Bradley, Calhoun, Columbia, Lafayette, Miller, Nevada, Ouachita, and Union). These parishes/counties are within 2 hours driving time of the facility (LES, 1994a). Population density for Claiborne Parish was 60 persons per square kilometer (23.1 persons per square mile) in 1990 (Department of Commerce, 1992b). The incremental and cumulative populations within 80 km (50 miles) of the CEC site (LES, 1994a) are presented in Table 3.42. These data were derived from the Oak Ridge National Laboratory Demographics Data file (LES, 1994a).

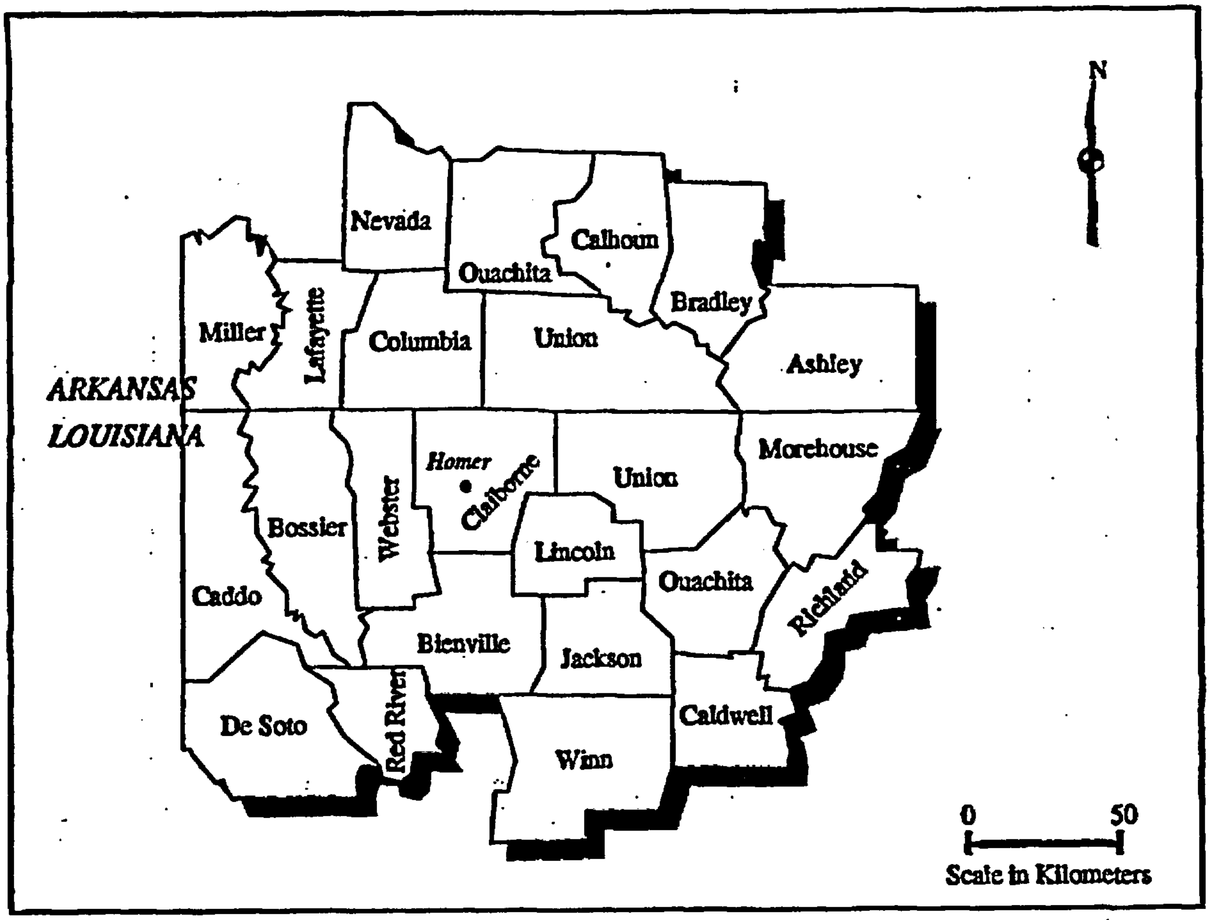

Figure 3.24 Counties and Parishes Providing Local Labor Pool for CEC

In Claiborne Parish, ethnic composition is 53.43 percent white, 46.09 percent black, 0.16 percent American Indian, 0.07 percent Asian, and 0.23 percent Hispanic (plus 0.01 percent "other"). More than 20 percent of the population in the seven-Parish area is over 55 years of age. About 41 percent is 22 to 54 years of age. About 12 percent is 16 to 21 years of age. In Claiborne Parish, about 27 percent of the population is over 55 years of age, and about 47 percent is between 18 and 54 years of age. Figures 3.25 and 3.26 show the estimated population and population distributions for the region within 8 km (5 miles) of the proposed facility. These population estimates were based on an actual household count. An average of 2.83 persons per household was estimated (LES, 1994a). The population is estimated to grow 28 percent above 1990 estimates by the year 2035 (LES, 1994a and 1993a) (Table 3.43). The nearest residential neighbors are located about 475 m (0.25 mile) away from the plant stacks (Table 3.44). The closest major population center, Shreveport, is 80 km (50 miles) to the southwest (Figure 3.16).

Tables 3.45, 3.46, and 3.47 show population, employment, and labor force data for the CEC labor supply area. This area comprises the seven parishes (including Claiborne) surrounding the LES site. The column labeled "school dropouts" on Table 3.46 shows the number of residents 16 years of age or more who have not graduated high school.

Table 3.42 Estimated Incremental Population for 1990 within 80 Kilometers (50 Miles) of the CEC Site (Adapted from LES, 1994a)

Distance (Miles) [a] / Direction	0-5	5-10	10-20	20-30	30-40	40-50	Cummulative Total
N	70	218	407	833	1977	2435	5940
NNE	61	182	540	2621	10373	1906	15683
NE	55	273	1162	5894	20851	1220	29455
ENE	43	253	895	1839	1704	3333	8067
E	34	126	2367	1430	5238	3501	12696
ESE	36	64	1240	1974	3005	8772	15091
SE	48	45	2047	23814	3352	2940	32246
SSE	50	148	1531	7676	3162	12419	24986
S	50	196	2361	2524	1315	2157	8603
SSW	63	288	1404	1981	2646	4531	10913
SW	181	1727	1370	18675	6539	5213	33705
WSW	127	2055	752	2178	7308	74494	86914
W	99	481	877	3273	1915	4935	11580
WNW	97	603	1494	5830	6426	2424	16874
NW	90	47	3020	2348	3471	5201	14177
NNW	1252	227	402	3152	14291	2944	21101
Total	2356	6933	21869	86042	93573	138425	348031
Cummulative Total	2356	9289	31158	117200	210773	349198 [b]	

[a] To convert to kilometers: km = m x 1.609

[b] Includes 1167 inmates at the Wade Correctional Institute.

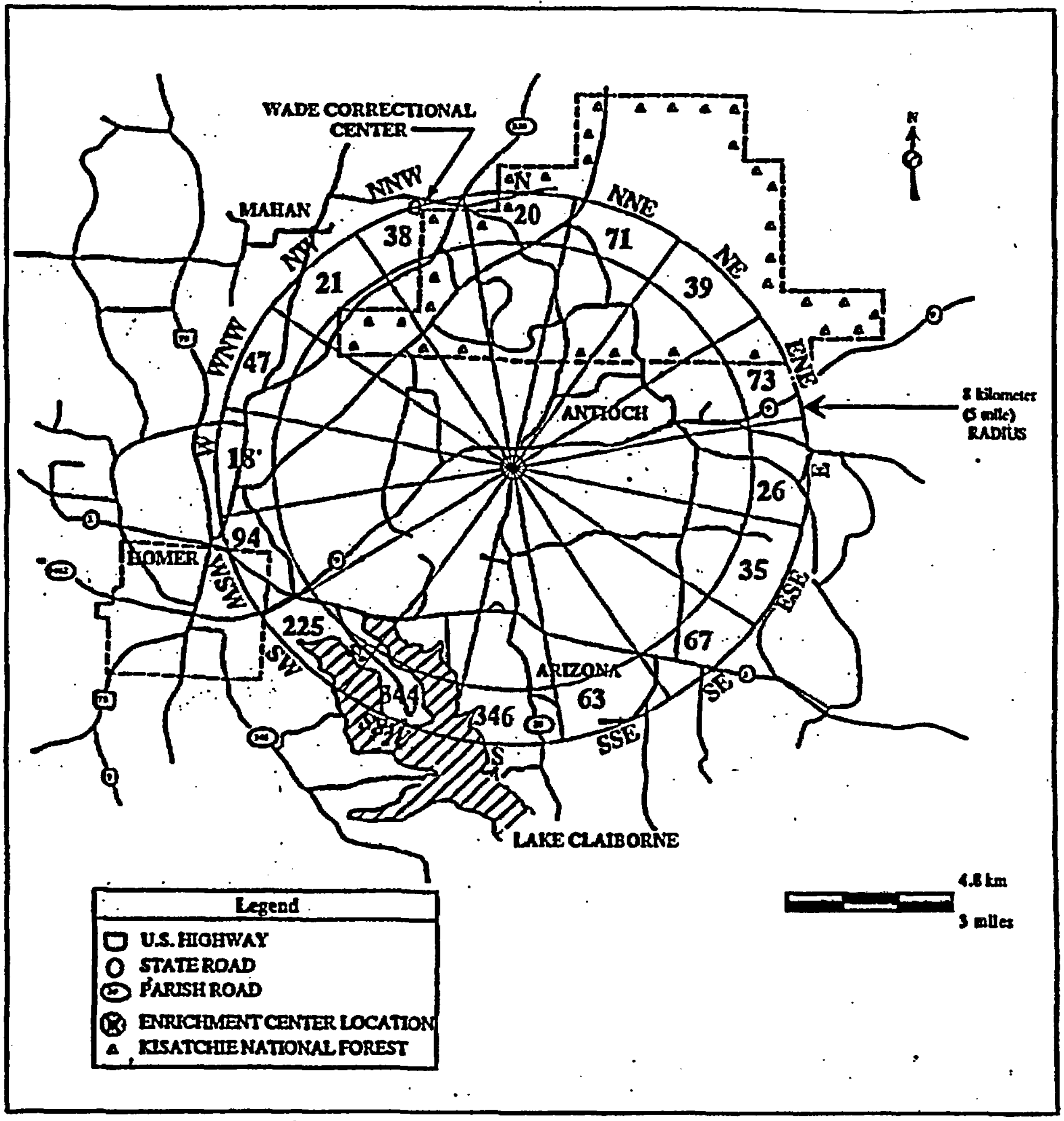

Figure 3.25 Estimated Population for 1990 within 8 km (5 miles) of the CEC Site (LES, 1994a)

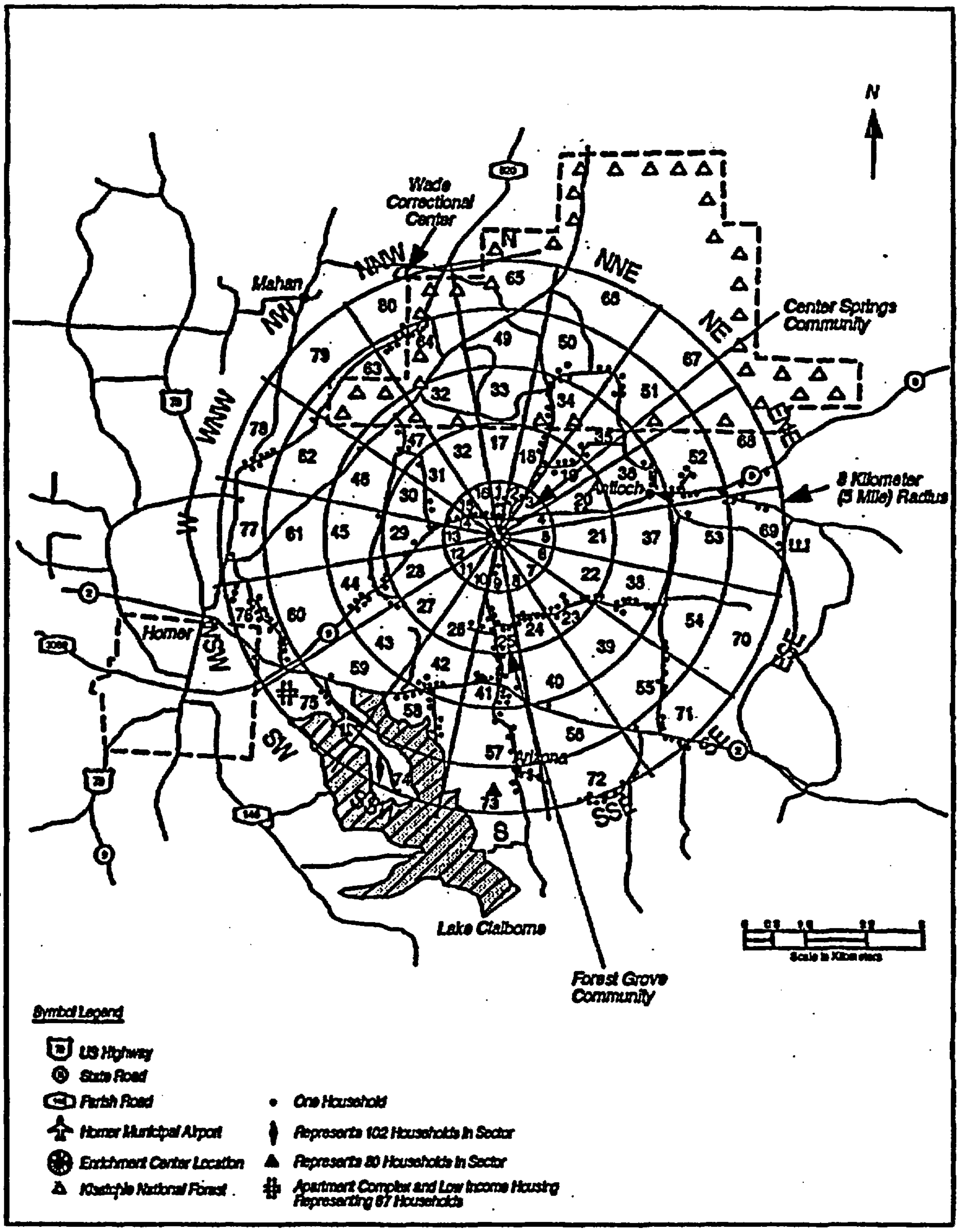

Figure 3.26 Location of Households in Each Sector within 8 km (5 miles) of the CEC Site (LES, 1994a)

Table 3.43 Estimated Population Within 8 Kilometers (5 Miles) of the CEC Site Between 1990 and 2035[a] (Adapted from LES, 1994a)

Sector Number	1990	2000	2010	2020	2030	2035
1	20	22	23	24	25	26
2	17	19	20	21	22	22
3	9	10	11	11	12	12
4	3	4	4	4	4	4
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	6	7	7	8	8	8
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	12	14	14	15	15	16
15	9	10	11	11	12	12
16	6	7	7	8	8	8
17	0	0	0	0	0	0
18	20	22	23	24	25	26
19	12	14	14	15	15	16
20	6	7	7	8	8	8
21	0	0	0	0	0	0
22	6	7	7	8	8	8
23	23	26	27	28	29	30
24	26	29	30	31	33	33
25	32	35	37	38	40	41
26	3	4	4	4	4	4
27	0	0	0	0	0	0
28	3	4	4	4	4	4
29	9	10	11	11	12	12
30	9	10	11	11	12	12
31	3	4	4	4	4	4
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	17	19	20	21	22	22
35	6	7	7	8	8	8
36	32	35	37	38	40	41
37	0	0	0	0	0	0
38	23	26	27	28	29	30
39	0	0	0	0	0	0
40	0	0	0	0	0	0
41	49	54	56	59	61	62
42	23	26	27	28	29	30
43	9	10	11	11	12	12
44	40	44	46	48	50	51

Table 3.43 Estimated Population Within 8 Kilometers (5 Miles) of the CEC Site Between 1990 and 2035[a] (Adapted from LES, 1994a) (Continued)

Sector Number	1990	2000	2010	2020	2030	2035
45	3	4	4	4	4	4
46	3	4	4	4	4	4
47	9	10	11	11	12	12
48	0	0	0	0	0	0
49	0	0	0	0	0	0
50	17	19	20	21	22	22
51	12	14	14	15	15	16
52	26	29	30	31	33	33
53	9	10	11	11	12	12
54	6	7	7	8	8	8
55	15	17	18	18	19	19
56	3	4	4	4	4	4
57	15	17	18	18	19	19
58	29	32	33	35	36	37
59	3	4	4	4	4	4
60	0	0	0	0	0	0
61	0	0	0	0	0	0
62	3	4	4	4	4	4
63	0	0	0	0	0	0
64	29	32	33	35	36	37
65	0	0	0	0	0	0
66	0	0	0	0	0	0
67	0	0	0	0	0	0
68	6	7	7	8	8	8
69	17	19	20	21	22	22
70	0	0	0	0	0	0
71	29	32	33	35	36	37
72	34	38	39	41	43	43
73	244	266	278	290	302	309
74	289	315	329	343	358	366
75	213	232	243	253	264	270
76	51	56	58	61	64	65
77	6	7	7	8	8	8
78	20	22	23	24	25	26
79	0	0	0	0	0	0
80[c]	1170	1171	1171	1171	1171	1171
Totals	2694	2858	2930	3007	3084	3122

[a] Based on an estimated population of 18526 persons in Claiborne Parish in 1990 and an average of 2.83 persons per household. In calculating the number of persons based on 2.83 persons per household, if the calculated value was a fraction, then that fraction was rounded upward (i.e., 17.18 would be reported as 18).

[b] See Figure 3.25 for sector identification.

[c] Includes 1167 inmates at the Wade Correctional Institute.

Table 3.44 Nearest Resident Within Each Compass Point Sector

Direction	Distance from Site Boundary to Nearest Resident	
	Miles	Meters
N	0.30	480
NNE	0.26	418
NE	0.43	690
ENE	1.56	2510
E	3.00	4830
ESE	1.91	3070
SE	1.48	2380
SSE	1.39	2240
S	0.56	900
SSW	1.61	2590
SW	3.74	6020
WSW	1.75	2820
W	1.13	1820
WNW	0.87	1400
NW	0.48	770
NNW	0.43	690

3.7.2 Employment

Employment in Claiborne Parish and the surrounding parishes is generally low-wage and low-skill. Per capita earnings for residents of Claiborne Parish is about $5,800 per year (Louisiana Tech. University, 1992). Surrounding parishes earn somewhat higher wages, although only Caddo Parish exceeds $9,000 per year. The average for the broadly defined LES labor market is only about $8,500 per year compared to a national average of almost $12,800. These figures (particularly the Claiborne Parish figures) make this region one of the poorest in the United States as measured by per capita earnings.

In terms of average wage structure, the LES region is at about $19,700 versus a national average of about $23,300 (Louisiana Tech. University, 1992). Manufacturing employment accounts for about 10 percent of the jobs in Claiborne Parish.

Table 3.47 shows that the composition of the work force in the construction categories needed for CEC is comparable to the makeup of the overall population. However, the labor for all skills may not be available from the labor pool (LES, 1992h). For the seven-

Table 3.45 Population, Employment, and Labor Force Data for the LES Labor Supply Area (Claiborne, Bienville, Lincoln, Union, Webster, Bossier, and Caddo Parishes), 1990 Part 1 - Labor Force Data, by Race and Sex, for Selected Skill Categories (Louisiana Department of Employment and Training, 1991)

	White			Minority			Total		
Occupation	Male	Female	Total	Male	Female	Total	Male	Female	Total
Construction Craftsmen	8,251	213	8,464	2,391	151	2,542	10,642	364	11,006
Mechanics & Repairmen	6,108	447	6,555	1,546	241	1,787	7,654	688	8,342
Machinists & Other Metal Craftsmen	4,147	544	4,691	808	274	1,082	4,955	818	5,773
Other Craftsmen	1,578	550	2,128	390	405	795	1,968	955	2,923
Operatives, Except Transport	6,526	4,091	10,622	4,722	4,584	9,306	11,248	8,675	19,928
Transport Equipment, Operatives	7,188	805	7,993	5,069	501	5,570	12,257	1,306	13,563
Truck Drivers	3,712	153	3,865	3,225	152	3,377	6,937	305	7,242
Totals	37,520	6,803	44,318	18,151	6,308	24,459	55,661	13,111	68,777

Table 3.46 Population, Employment, and Labor Force Data for the LES Labor Supply Area (Claiborne, Bienville, Lincoln, Union, Webster, Bossier, and Caddo Parishes), 1990 Part 2 - Population, Employment, and Labor Force Data for Selected Age Groupings (Louisiana Department of Employment and Training, 1991)

	Age						
Parish	16-21	22-54	55+	Total Labor Force	Total Employed	Total Population	School Dropouts
Claiborne	1,789	6,003	5,094	7,100	6,550	17,405	6,020
Bienville	1,650	5,799	4,362	6,576	6,104	15,979	5,175
Lincoln	10,815	14,963	7,504	17,623	17,019	41,745	6,813
Union	2,078	7,714	5,491	8,071	7,512	20,690	6,682
Webster	4,496	16,321	10,689	18,288	16,716	41,989	12,318
Bossier	10,798	39,348	11,589	35,575	33,030	86,088	14,074
Caddo	26,690	103,732	51,787	118,065	110,350	248,253	54,254
Totals	58,316	193,880	96,516	211,298	197,281	472,149	105,336

Parish area, males make up over 80 percent of the workers in the required construction categories (Louisiana Department of Employment and Training, 1991). Unemployment in the Parish and in the State was about 8 percent recently (Louisiana Department of Labor,

Table 3.47 Population, Employment, and Labor Force Data for the LES Labor Supply area (Claiborne, Bienville, Lincoln, Union, Webster, Bossier, and Caddo Parishes), 1990 Part 3 - Population, by Race and Sex and by Parish (Louisiana Department of Employment and Training, 1991)

Parish	White Male	White Female	Minority Male	Minority Female	Total Male	Total Female	Ratios, Male: White to Minority	Ratios, Female: White to Minority
Claiborne	4,425	4,804	3,874	4,303	8,299	9,107	1.14	1.12
Bienville	4,449	4,706	3,245	3,579	7,694	8,285	1.37	1.31
Lincoln	13,120	12,771	7,686	8,168	20,806	20,939	1.71	1.56
Union	7,084	7,510	2,861	3,234	9,945	10,744	2.48	2.32
Webster	13,907	14,537	6,219	7,327	20,126	21,864	2.24	1.98
Bossier	34,326	34,176	8,331	9,255	42,657	43,431	4.12	3.69
Caddo	72,443	80,206	43,913	51,690	116,356	131,896	1.65	1.55
Totals	149,754	158,710	76,129	87,556	225,883	246,266	1.97	1.81

1992). Minority unemployment is minimally 50 percent greater than white unemployment. This relationship is consistent with national figures.

3.7.3 Economic Conditions

Total personal income in Claiborne Parish rose 5.5 percent from 1986 to 1990, from $172 million in 1987 to $194 million in 1990 (Department of Commerce, 1992a). Tax revenues in the area in 1990 were $3,290,000. The assessed property value in the parish in 1992 partially recovered from a decrease in average property values from 1990 to 1991. Table 3.48 shows per capita income, which includes social security, interest and dividends, and transfer payments. Thus, these figures are considerably higher than per capita earnings as defined in the previous section.

3.8 Land Use

Eight km (5 miles) of predominantly wooded lands surround the proposed facility. Forested land in the area consists primarily of deciduous forest and mixed evergreen/deciduous forest land. Agriculturally, the land is predominantly used for pasture (Figure 3.27). Approximately 370 hectares (920 acres) within the 8-km (5-mile) radius are designated for agricultural use, including six cattle ranches. The closest beef cattle ranch is located approximately 2.4 km (1.5 miles) west of the proposed site, and the remaining ranches are found 4.8 km (3 miles) east, 6.4 km (4 miles) east, 6.4 km (4 miles) south, 7.2 km (4½ miles) southeast, and 8 km (5 miles) southwest of the proposed site. The largest of the ranches

Table 3.48 The Calculated 1988-92 Total Personal Income and Per Capita Personal Income for Claiborne Parish (Department of Commerce, 1992a)

	Total Personal Income					Per Capita Personal Income				
	Millions of Dollars				Percent Change	Dollars				Rank
	1988	1989	1990	1991	1986-91	1988	1989	1990	1991	1991
Claiborne Parish	182	184	194	—	5.5	10,186	10,453	11,190	—	47 in State of LA
State of Louisiana	53,875	56,230	60,131	63,970	4.8	12,611	13,221	14,279	15,046	45 in the U.S.A.
Non-Metropolitan Louisiana	13,347	13,740	14,849	—	8.1 (1989-90)	10,171	10,586	11,586	—	---

maintains a herd of 68 head of beef cattle (LES, 1994a). No major crops are produced within 8 km (5 miles) of the facility location.

The northern end of Lake Claiborne is nonforested wetland habitat. A forested wetland habitat is found north of this area, approximately 3.2 km (2 miles) south of the proposed site location.

Land is used for residential purposes west and southwest of the proposed site. Residential areas are more densely populated near Homer and along Lake Claiborne within 8 km (5 miles) of the proposed site. Also, residences along State Highway 9 are within the 8-km (5-mile) radius (LES, 1994a). The Center Springs community lies about half a kilometer to the north and the Forest Grove community, approximately 3.2 kilometers south of the site. The NRC staff is not aware of any conflicting plans, acts, or policies for the land use of the proposed CEC site.

Northwest, west, and southwest of the proposed facility location are commercial and public service types of land use. The Wade Correctional Institute is located approximately 6 km (4 miles) north northwest (NNW) of the proposed site. The usually full facility has a capacity of 1,167 inmates (LES, 1994a).

Thirty-one active oil and gas wells and four distribution pipelines are located within an 8-km (5-mile) radius of the site (LES, 1994a), comprising the only industry located in the vicinity of CEC. There are several limited outcroppings of iron on the CEC site. LES has no plans for utilizing this resource now or in the future (LES, 1992d).

There is no future land use plan or zoning at the CEC site. CEC site is outside Homer's jurisdiction and in the Parish's jurisdiction. Claiborne Parish has no planned or conceived future zoning changes in terms of jurisdiction, rules, or procedures (Dane, 1994).

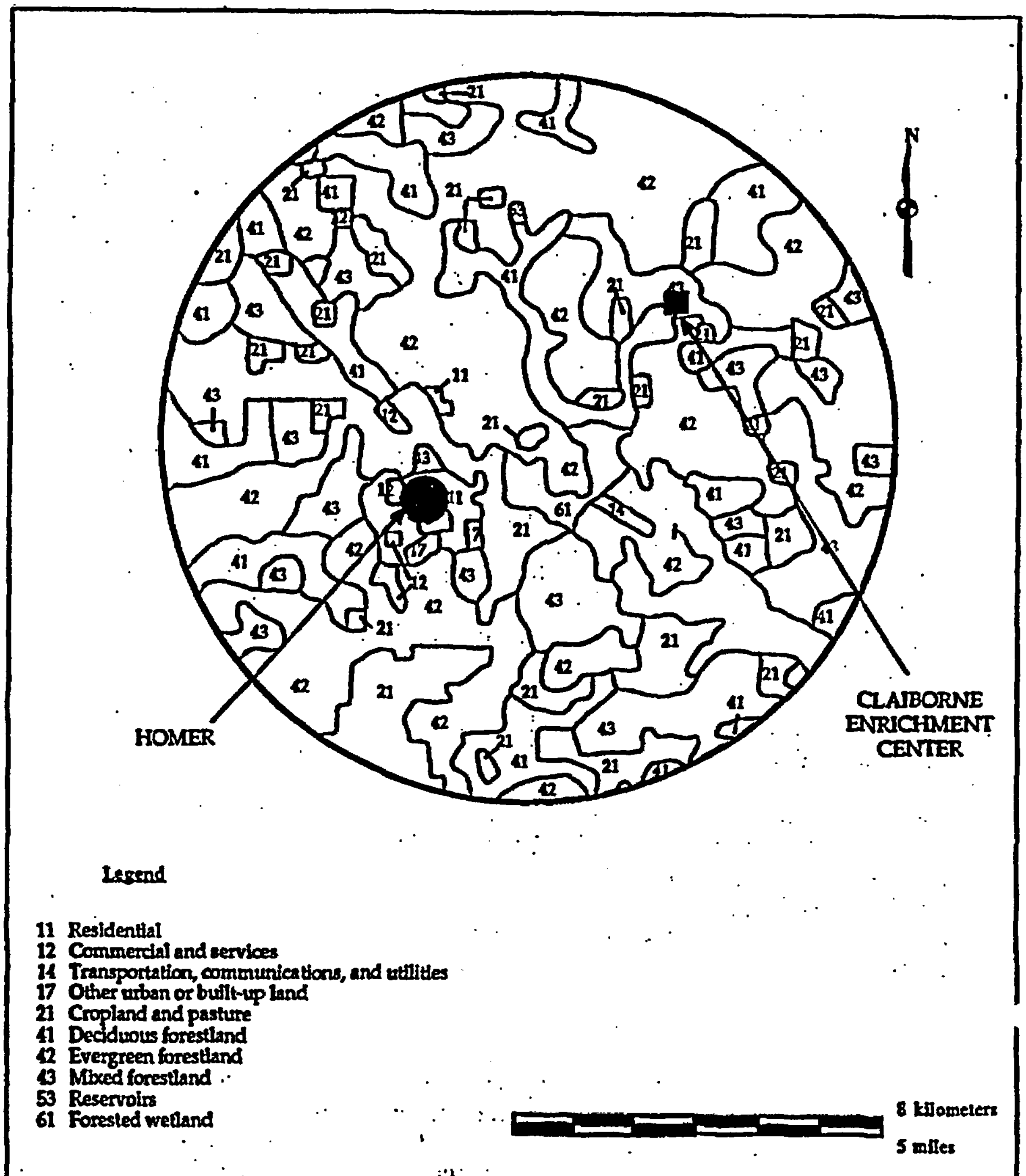

Figure 3.27 Land Use in the Vicinity of the CEC Site (Louisiana Geological Survey, 1982)

3.9 Noise and Traffic

3.9.1 Noise

As typical of fields and forest land, the site under present conditions is quiet. Two nearby roads contribute substantially to the noise in the area, but the level of noise from light traffic is not normally a problem. The site does occasionally experience high levels of noise during daylight hours due to the harvesting of trees. These levels, sufficient to irritate nearby observers, will not always be attenuated by distance or structures since cutting occurs up to the edge of the property. These nonroutine operations may occur enough to bother people. However, long-term hearing loss in residents is unlikely as workers exposed to less than 80 decibels (dB) for 8 hours every working day have not shown higher hearing loss than nonexposed persons (Lord et al., 1980). Temporary hearing loss, or auditory fatigue, for workers or close observers not wearing ear protection would be expected. Auditory fatigue normally dissipates in a few hours.

Noise is a subjective term for unwanted sound pressure waves. Measuring the magnitude of sound is fairly easy, but determining the level of noise is not. Various activities and perceptions help determine acceptable levels of noise. For example, a student may be bothered by a pencil tapping on a desk during a test, but this noise may not even be perceived during recess. Sound is conveniently measured using decibels (dB), and measurements are properly given as a decibel value and a distance from the source of the sound (because the sound decreases with distance). This scale closely approximates the way humans perceive sounds.

No noise survey has been conducted at the site, but knowledge of the site and activities occurring at the site and nearby is sufficient to estimate the noise levels expected at the site on a continuous and intermittent basis. Table 3.49 identifies common activities and equipment and the associated noise levels. This table shows that the noise level at the site is usually 30 to 40 dB due to wind noise, rustling of leaves, and birds. However, cutting trees with chain saws (100 dB), using heavy trucks to move the trees (95 dB), and road traffic (~70 dB) all contribute to making the existing site fairly noisy to those nearby. Most of these activities are concentrated during the day, when noise is tolerated better than at night.

3.9.2 Traffic

Traffic in the community is generally light; except for brief periods in some limited areas (i.e., Homer Courthouse Square), there are no significant holdups in traffic flow. A summary of the daily vehicle count for selected roads is presented in Table 3.50. Two main arteries enter the town of Homer, U.S. 79 and LA 9, with LA 2 and LA 146 being the other significant roads. Three other larger roads will be impacted by LES: LA 167, which connects El Dorado and Ruston; 152 (a shortcut between LA 167 near Ruston and the site); and LA ALT 2.

Table 3.49 Noise Levels for Various Activities and Equipment (Lord et al., 1980)

Source	Decibels (dB)
normal breathing	10
rustling leaves	20
whispering	30
library	40
quiet office	50
light auto traffic at 30 meters	50
typical office	60
conversational speech	60
automobile	68
vacuum cleaner at 3 meters	69
busy traffic	70
freight train at 15 meters	75
alarm clock at 0.6 meters	80
riding inside a city bus	83
pickup truck	85
home shop tools	85
loud radio	85
lawn mower	87
heavy truck at 15 meters	90
diesel electric generator	94
motorcycle	95
chain saw	100
construction noise at 15 meters	110
circular saw	110
rock concert	120
jet takeoff at 60 meters	120
threshold of physical pain	130

Table 3.51 shows the number of vehicles registered in Louisiana and in Claiborne Parish.

3.10 Cultural, Historic, and Archaeological Resources

Claiborne Parish contains a number of cultural and historic sites, including museums, historic districts, national forests, and State parks. The cultural and architectural trends and traditions of Claiborne Parish are influenced by Anglo-Saxon (rather than French) cultures (Ruston Daily Leader, 1991).

3.10.1 Cultural Resources

The Herbert S. Ford Museum, located in the historic Hotel Claiborne in the Town Square of Homer, displays artifacts from the North Louisiana Hill country, including artifacts from the Pioneer period, Civil War period, and the railroad, lumbering, and oil eras of the region. The annual 3-day Bluegrass Festival held every summer in Athens [24 kilometers (15 miles)

Table 3.50 1990 Local Daily Traffic Counts, Major Roads Entering Claiborne Parish (Louisiana State Department of Transportation and Development, 1990)

Roadway	Road Segment	Daily Count Minimum	Daily Count Maximum
I-20	Between Ruston and LA 9 exit	13770	17120
I-20	From west to east side of Webster Parish	16310	18910
U.S. 79	From intersection with S. LA 9 to intersection with S. LA 531 in Minden	3150	5050
U.S. 79	From west side of Webster Parish to SW boundary of Minden	2170	8090
U.S. 79	From south border of Haynesville to north border of Homer	3160	4240
U.S. 79	From AR State line to north border of Haynesville	1500	3280
U.S. 79	North of Homer Square to LA 2	9380	
U.S. 79	South of Homer Square to LA 146	10200	
U.S. 79	South of Homer limit		6070
LA 9	3rd and 4th Streets		6540
LA 9	Homer city limits		2760
LA 9	From LA 155 in Bienville Parish to LA 517	720	1230
LA 9	From LA 517 to LA 147	670	1700
LA 9	From LA 147 to Claiborne line	1760	2180
LA 9	From south Claiborne line to junction with U.S. 79	1210	2970
LA 9	From LA 2 to LA ALT 2	1220	1970
LA 9	From LA ALT 2 to Union Parish line	1130	1180
LA 2	From LA 9 to Lisbon	1400	1770
LA 2	From Lisbon to Union Parish Line	950	1400
LA 2	U.S. 79 and LA 9		2130
LA 2	From Sarepta to Shongaloo	1040	1240
LA 2	From Shongaloo to Homer	690	830
LA ALT 2	From U.S. 167 to LA 9	690	760
LA ALT 2	From LA 9 to LA 161	440	680
LA 146	From Homer to Lincoln line	530	1570
LA 146	3rd and Main		1830
LA 146	From Lincoln line to Vienna	520	1070

Table 3.51 Registered Vehicles in Louisiana and Claiborne Parish (Hargrove, 1992)

	Louisiana		Claiborne Parish	
	Registered	Per Capita	Registered	Per Capita
Automobiles	3,199,846	0.758	14,688	0.844
Motorcycles	79,678	0.019	409	0.023
Trucks	1,451,141	0.344	9,109	0.523
Buses	31,446	0.0074	188	0.0108
House Trailers	167,073	0.040	1,395	0.080
Other Trailers	560,263	0.133	3,614	0.208

south of the site] presents a mix of regional musical styles. The Annual Sidewalk Art Show in Homer presents regional arts and crafts.

Claiborne State Park, located at the southern end of Lake Claiborne, has weekend, vacation, and permanent homes as well as camp sites. Activities at the park include boating, fishing, swimming, hiking, picnicking, and camping.

3.10.2 National Register of Historic Places

The United States National Register of Historic Places has identified nine historic sites located within Claiborne Parish (National Register, 1991). Eight of these sites are located within a 32-kilometer (20-mile) radius of the proposed facility. Five of these sites, including a historic district, are in Homer. The remaining historic sites are located in Haynesville, Marsalis, and Summerfield.

Homer's historic district is roughly bordered by North Second, East Main, South Third and West Main Streets. The historic district includes the Courthouse, the Confederate Soldier Statue, and the Claiborne Hotel (1890) which now houses the Ford Museum.

The Claiborne Parish Courthouse, built in 1860, served as a departure point for Confederate troops during the Civil War. The building itself, an example of the Greek Revival architectural style, is located at Courthouse Square in Homer.

Two additional examples of Greek Revival structures in Homer are the Capers-McKenzie House, located on 612 North Fifth Street (1860) and the Todd House, located on 306 Pine Street (1872).

The Arizona Methodist Church (1882) is located in the Arizona community, approximately 5 km (3 miles) south of Homer.

The Alberry Wasson Log House and Museum, located approximately 2.4 km (1.5 miles) south of Summerfield, was built in 1850 by Alberry Wasson. The house, which displays artifacts of the pioneer Wasson family, represents 19th century pioneer architecture.

Table 3.52 provides a listing of all historic sites and the location of these sites within Claiborne Parish in relation to the proposed site.

3.10.3 Natural Landmarks

The major natural and manmade landmarks in the region consist of Lake Claiborne, a 2,586 hectare (6,400 acre) manmade lake completed in 1966, and Dogwood Trail and Carney Lake, both located in Kisatchie National Forest (Ruston Daily Leader, 1991).

3.10.4 Archaeological Resources

The State of Louisiana, Department of Culture, Recreation, and Tourism, Office of Culture Development has determined that the site for the proposed facility has a moderate potential for containing archaeological sites. A study conducted by Survey Unlimited Research Associates May 7-14, 1991, on 97 percent of the land area of the proposed site location, has concluded that the area contained no historic or prehistoric cultural resources of importance. The Office of Cultural Development, Department of Culture, Recreation, and Tourism of the State of Louisiana indicates that no significant cultural resources will be affected by CEC construction (Rivet, 1992 and Hobdy, 1992).

The survey identified eight areas of potential historic interest at the site (Shuman, 1991). A brief description of these sites is in Table 3.53. The potential cultural resource locations at CEC site, identified in Figure 3.28, were found to have no cultural or historic significance.

Prior to this study, one archaeological site was reported within 8 km (5 miles) of CEC site. This archaeological site, consisting of prehistoric pottery pieces and lithics, is located at the 8-km (5-mile) boundary southeast of CEC site. The archaeological site has not been officially recorded with the Division of Archaeology.

The Claiborne Temple mounds, which consist of five Indian mounds dating from 300-500 A.D., located off of LA 9, are approximately 16 kilometers (10 miles) north of the proposed facility location (Ruston Daily Leader, 1990).

3.11 Background Radiological Characteristics

The background radiological characteristics of the proposed CEC site are the result of a variety of natural and manmade sources of radiation and radioactivity that contributes to the radiation exposure of the public. The National Council on Radiation Protection and Measurements (NCRP, 1987a) considers three sources of exposure: naturally occurring radionuclides (e.g., so-called primordial radionuclides such as uranium-238, thorium-232,

Table 3.52 Claiborne Parish Historic Sites (National Register, 1991)

Historic Site	Location	Distance from CEC
1. Arizona Methodist Church	Arizona, LA	5.6 km NE
2. Capers-McKenzie House	N. Fifth Street Homer	8 km SW
3. Claiborne Parish Courthouse	Courthouse Square Homer	8 km SW
4. Homer Historic District	Bordered by: N. Second, E. Main, S. Third and West Main Streets	8 km SW
5. J. W. Todd House	306 Pine Street Homer	8 km SW
6. Kilgore House	Jct. of LA 2 LA 518 Lisbon	16 km E
7. J. W. Burnham House	Off US 79 Haynesville	24 km NW
8. Alberry Wasson House	Off LA 9 1½ miles south of Summerfield	24 km NE
9. Tulip Methodist Church	Off LA 518 Marsalis	24 km S

uranium-235, potassium-40 and rubidium-87, and cosmogenic radionuclides such as tritium, beryllium-7, carbon-14, and sodium-22); external radiation from outer space (cosmic) and gamma radiation from terrestrial radionuclides (e.g., potassium-40, and thorium and uranium progeny); and internal radiation from radionuclides in the human body that are primarily ingested in food and water or inhaled (e.g., potassium-40, uranium and thorium and their progeny, rubidium-87, and carbon-14).

The average annual effective dose equivalent from terrestrial gamma radiation is about 0.28 mSv (28 mrem), while the average annual cosmic ray dose equivalent at sea level is about 0.26 mSv (26 mrem) (NCRP, 1987a). These two sources of exposure vary primarily geographically and by altitude, respectively. The principal source of cosmogenic radiation exposure, carbon-14, results in an average annual effective dose equivalent of about 0.01 mSv (1 mrem). The largest single contributing source of natural radiation exposure is

Table 3.53 Areas of Potential Cultural Resources at the CEC Site (Shuman, 1991)

Location Identification	Site Description
A	Site of a collapsed tenant house used between 1930-1955 (outhouse and water well also identified) along LA 806.
B	Remnants of livestock pens and a water well along LA 806.
C	Scattered materials of recent age (tiles, cement, bolts, bicycle chain, pottery shards) along a logging road.
D	East side of logging road. Shovel test revealed a metal hook.
E	Possible tenant homesite.
F	Glass bottle fragments along logging road.
G	An isolated projectile point of White Paleozoic Chert from 2,000 B.C. to 500 A.D.
H	Camping site developed in the 1960s by Mr. and Mrs. LeSage - failed the age criterion for National Register eligibility.

from inhalation of indoor progeny of radon-222 (which comes from the radioactive decay of uranium-238 and its daughter product, radium-226). Inhalation of radon progeny (primarily indoors) results in an average annual effective dose equivalent of about 2 mSv (200 mrem). When combined with the other sources, the average U.S. citizen receives about 3 mSv (300 mrem) each year.

Measurements of external gamma radiation and cosmic radiation in the vicinity of the site (near Ruston, LA) by Oak Ridge National Laboratory (ORNL, 1981) suggest an average annual exposure rate of about 1.4x10-5 C/kg (53 mR). For practical purposes, these measurements are comparable to the average U.S. annual effective dose equivalent of about 0.54 mSv (54 mrem) estimated by the NCRP for combined terrestrial gamma and cosmic radiation doses (NCRP, 1987b).

In addition to measurements of external penetrating radiation, NCRP (1987b) has also estimated average concentrations of the principal primordial radionuclides in air, water, soil, and vegetation in the U.S. The average concentrations of naturally-occurring uranium (234, 235, and 238 combined) in air, water, soil, and vegetation were estimated to be on the order of 7×10^{-13} Bq/ml (2×10^{-17} μCi/ml), 4×10^{-6} Bq/ml (1×10^{-10} μCi/ml), 7×10^{-2} Bq/g (2×10^{-6} μCi/g), and 4×10^{-5} Bq/g (1×10^{-9} μCi/g), respectively. ORNL estimated that the content of uranium-238 in soil near the CEC site was approximately 2×10^{-2} Bq/g (5×10^{-7} μCi/g), or less than half of the national average (ORNL, 1981).

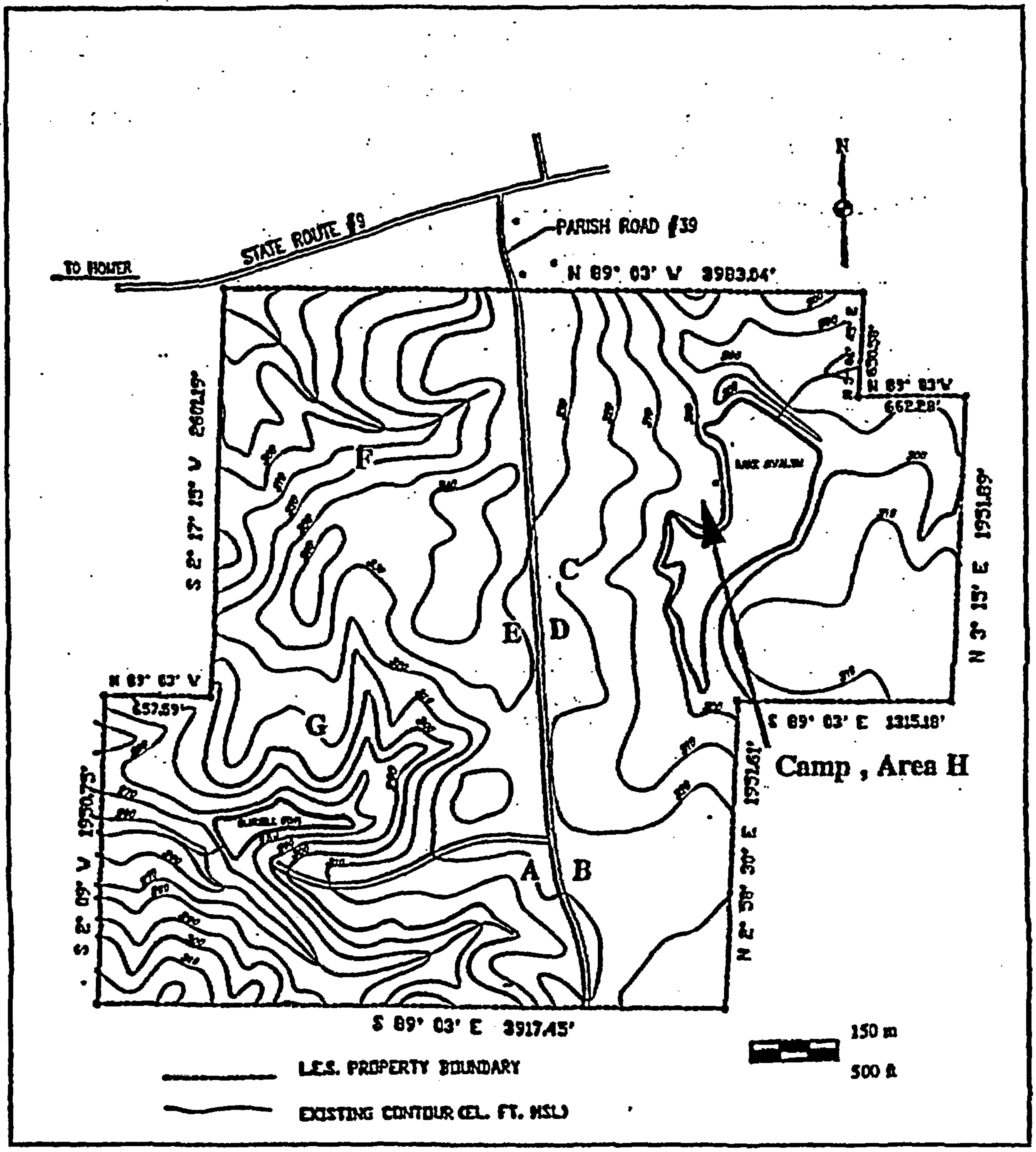

Figure 3.28 Locations of Cultural Resources at CEC Site (Adapted from Shuman, 1991)

LES conducted a preliminary analysis of the background radiological characteristics of the proposed CEC site. The results are summarized in Table 3.54. The average measurement for combined terrestrial and cosmic radiation in the table (10 μR/hr) is comparable to about $2.3x10^{-5}$ C/kg (88 mR per year), which is somewhat higher than the ORNL measurements reported in 1981 (ORNL, 1981). A more detailed preoperational radiological environmental monitoring program will be conducted prior to completion of construction and operation of the CEC, as described in Section 5.1.2.

Table 3.54 Summary of Radiological Conditions Found at the Proposed Location of the CEC when Screening Measurements were Performed Prior to the Preoperational Radiological Monitoring Program (LES, 1994a)

Sample Type Collected	# Samples Collected	Nuclides Identified	Activity Range	Activity Mean
Airborne Radioiodines	4	none (a)	(b)	(b)
Airborne Particulates	4	none (a)	(b)	(b)
Broad Leaf Vegetation	12	^{137}Cs (a)	(c)	115 pCi/kg
Surface Water	21	none (a)	(b)	(b)
Groundwater	15	none (a)	(b)	(b)
Sediment	16	^{137}Cs (a,d)	64-4534	1044 pCi/kg
Soil	38	^{137}Cs (a,e)	133-1123	698 pCi/kg
Direct Radiation (f)	37	none	0.006-0.015	0.010

(a) Gamma spectroscopy analysis only; not capable of measuring natural uranium background.
(b) No nuclides identified, therefore no activity range or mean exists.
(c) No range exists because only one sample was determined to have activity.
(d) Positive identification of ^{137}Cs was made in 16 of 16 samples. Cesium is found due to nuclear testing fallout.
(e) Positive identification of ^{137}Cs was made in 24 of 38 samples.
(f) Direct radiation measured with thermoluminescent dosimeters (mR)/hour.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter assesses and analyzes the potential environmental impacts associated with the construction, operation, and decommissioning of the proposed uranium enrichment facility at CEC. The "no-action" alternative is assessed as required by the Council on Environmental Quality (CEQ) regulation 40 CFR Part 1500 and NRC regulations in 10 CFR Part 51. The environmental analysis contained in this EIS includes all communities surrounding the proposed CEC site.

Section 4.1 addresses the potential impacts of site preparation and construction activities. The impacts associated with the facility operation are addressed in Section 4.2. Section 4.3 presents the potential impacts of decontamination and decommissioning (D&D).

4.1 Site Preparation and Construction Description

This section analyzes the potential environmental impacts associated with site preparation and construction of the CEC facility, which is scheduled to begin with site preparation in 1995. LES is constructing the 1.5 million SWU per year plant in three phases, each producing 0.5 million SWU per year at full output. Constructing the complete plant will take place over approximately 6 years. LES will use construction methods and procedures designed to minimize environmental impacts (LES, 1994a).

Potential impacts from site preparation and construction activities arise largely from the alteration of the land surface and are limited to local terrestrial habitats, site hydrology, and air quality. Construction of the CEC will not cause the relocation of any family. The land is owned by LES; no family dwellings occur on the site. This section describes each of these potential environmental consequences.

4.1.1 Hydrology

The potential impacts of site preparation and construction activities on local hydrology include changes in the flow rate and direction of surface water, in the elevation and flow direction of groundwater beneath the site, and in the quality of surface water and groundwater.

Site preparation and construction activities such as excavation and filling for the facility foundation, parking lots, and storage yards will alter the topography of the site (LES, 1994a). The potential impacts to surface water include changes in the amount of infiltration and runoff of surface water and effects to surficial drainage patterns. The clearing of site vegetation and the movement of construction equipment will compact site soils, decrease infiltration, and increase both runoff and the potential for soil erosion.

The facility foundation, tails storage yards, and parking lots will be constructed on the drainage divide between the Bluegill Pond Drainage Basin and the Lake Avalyn Drainage Basin (Figure 4.1). All surface water runoff originating within this area will be routed to one outfall at the start of construction activities and discharged to the Hold-Up Basin (Figure 4.2). All site runoff will be directed to the Hold-Up Basin to allow for the settling of eroded soils and sediment. The water effluents from the Hold-Up Basin to Bluegill Pond must meet the Louisiana Department of Environmental Quality (LDEQ) standards for total suspended solids (TSS) of 45 mg/l. LES estimates TSS in the effluents from the Hold-Up Basin would range from 0.0 to 20.8 mg/l, well below the LDEQ standard.

Surface runoff from the portion of the Lake Avalyn drainage area to be covered by the facility (approximately 15 hectares or 37 acres) will be directed to the Bluegill Pond drainage area. It is estimated that 20 percent of the total annual surface runoff into Lake Avalyn under baseline conditions will be diverted to the Hold-Up Basin as a result (LES, 1994a). The current annual discharge into Lake Avalyn averages 286,000 m^3/year (0.32 ft^3/sec). The amount of runoff from the portion of the Lake Avalyn drainage that will be diverted through the site yard drains is about 51,000 m^3/yr, or approximately half of the measured volume of Lake Avalyn. Therefore, the shoreline of Lake Avalyn is likely to recede somewhat, and the lake chemistry may change as a result of the reduced runoff (LES, 1994a).

Site preparation and construction would contribute to a corresponding decrease in the average natural annual surface runoff to Bluegill Pond because a portion of its Drainage Basin will be covered. It is estimated that the decrease would amount to approximately 22,400 m^3 or nearly 30 percent of the annual surface water runoff of 78,400 m^3 under baseline conditions (LES 1993b). On an annual basis, therefore, water nearly equal the Pond's volume will not be available for natural recharge. This surface runoff, however, will be directed to the Hold-Up Basin for sedimentation control, ultimately flowing into Bluegill Pond. Also, Bluegill Pond will be receiving the diverted drainage from Lake Avalyn. Accordingly, Bluegill Pond is not expected to experience a noticeable change in water volume other than volume changes from seasonal variations.

Site preparation and construction activities (i.e., soil excavation, filling, grading, paving, and foundation construction) may also impact the existing groundwater recharge area for the shallow aquifer. LES defined the existing elevation and flow direction of the shallow aquifer in the Cockfield Formation during initial site investigation activities. The shallow groundwater flows southwest and northeast from a divide that runs northwest to southeast (Figure 3.14). Facility construction activities will create impermeable surfaces, decreasing infiltration of precipitation over a portion of the groundwater recharge area. Precipitation falling on this area will be directed to runoff drains rather than infiltrate shallow groundwater. No more than 28 hectares of the 179-hectare CEC site (16 percent) will be affected, and the resulting change in groundwater recharge will have no significant impact on local shallow water supply wells in the vicinity of the site. Shallow groundwater depth onsite may decline as a result. The amount of groundwater discharging to Lake Avalyn will

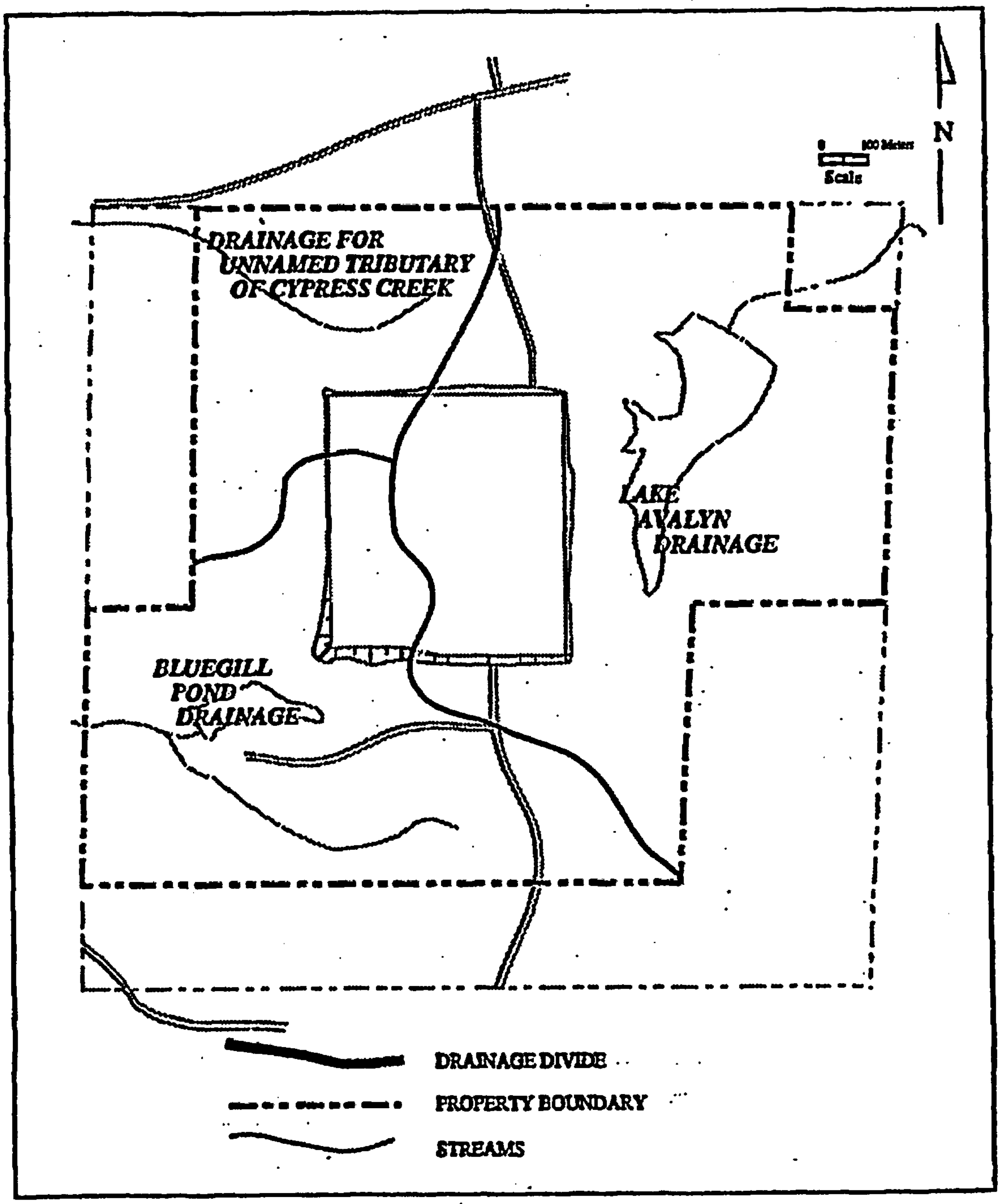

Figure 4.1 · Delineation of the Three Water Drainage Areas at CEC (Adapted from LES, 1994a)

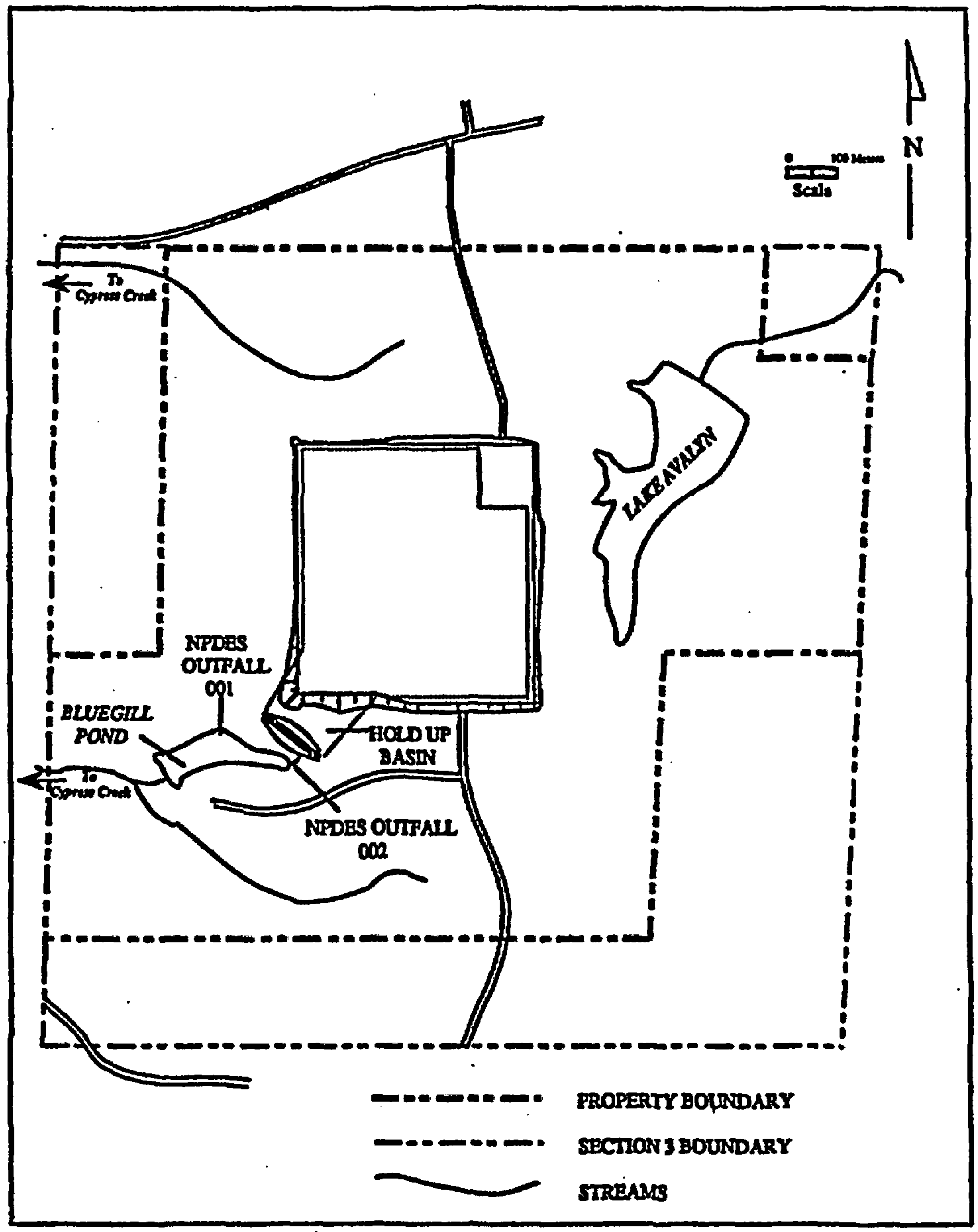

Figure 4.2 Location of the Site Hold-Up Basin and Effluent Discharge Outfalls at CEC (Adapted from LES, 1994a)

also be reduced. LES estimates that the lowering of the shallow aquifer will not likely extend beyond CEC property boundaries and will not affect offsite wells to any significant degree (LES, 1994 and 1992h). During construction, site runoff will be directed to the Hold-Up Basin (Figure 4.2). Infiltration of water stored in the Hold-Up Basin to shallow groundwater may increase the elevation of the underlying groundwater (LES, 1994a). No additional liquid effluent discharge to Bluegill Pond is expected during site preparation and construction. The staff concludes that domestic production of groundwater from offsite wells should not be adversely impacted.

Construction activities will include the installation of two water supply wells in the Sparta Sand Aquifer (Figure 4.3), each equipped with a 190 liter (50 gallon) per minute pump. The Cook Mountain confining layer separates the Sparta Sand Aquifer from the shallow Cockfield Formation Aquifer. No significant immediate changes in the Sparta Sand Aquifer are expected to occur as a result of the installation and development of these wells. The long-term impacts of pumping groundwater from these wells during facility operation are addressed in Section 4.2.1.

Site preparation and construction activities also may impact the quality of the local surface water and groundwater. Site preparation will require the clearing of vegetation, perhaps creating the potential for subsequent soil erosion, especially during normal precipitation and storm events.

Surface waters could experience increased sedimentation during such events, as evidenced by the increased turbidity of Bluegill Pond following the timbering activities conducted recently on the site (Davis, 1990a and 1990b). LES plans to apply all necessary mitigation measures during this phase to minimize soil erosion and sedimentation in Bluegill Pond.

Grading of the site to produce a level surface for facility structures and storage yards will require excavation and filling of site soils, the volume of which is provided in Table 4.1. Dikes, berms, silt fences, and sediment traps will help minimize soil erosion during construction. The Hold-Up Basin will minimize the amount of site soil released to surface water. During the construction period, approximately 13,568 m^3 (11 acre-feet) of sediment is expected to be captured in the Hold-Up Basin (LES, 1994a). Water discharge from the Hold-Up Basin to Bluegill Pond is limited to 45 mg/l TSS as required by LDEQ standards. This controls the amount of sedimentation in Bluegill Pond. If the capacity of the Hold-Up Basin is exceeded, local surface waters may experience a temporary increase in the amounts of sedimentation and turbidity.

During site preparation and construction, the potential also exists for impacts to surface water as a result of fuel or oil spills from heavy construction equipment and onsite storage of fuels. These substances may be accidentally released during routine operation of construction equipment because of operator error, or from the failure of a fuel storage tank. Mass movement of soils during site preparation and construction could potentially disrupt fuel storage tanks or fuel transport vehicles, resulting in a spill or release of fuel or oil.

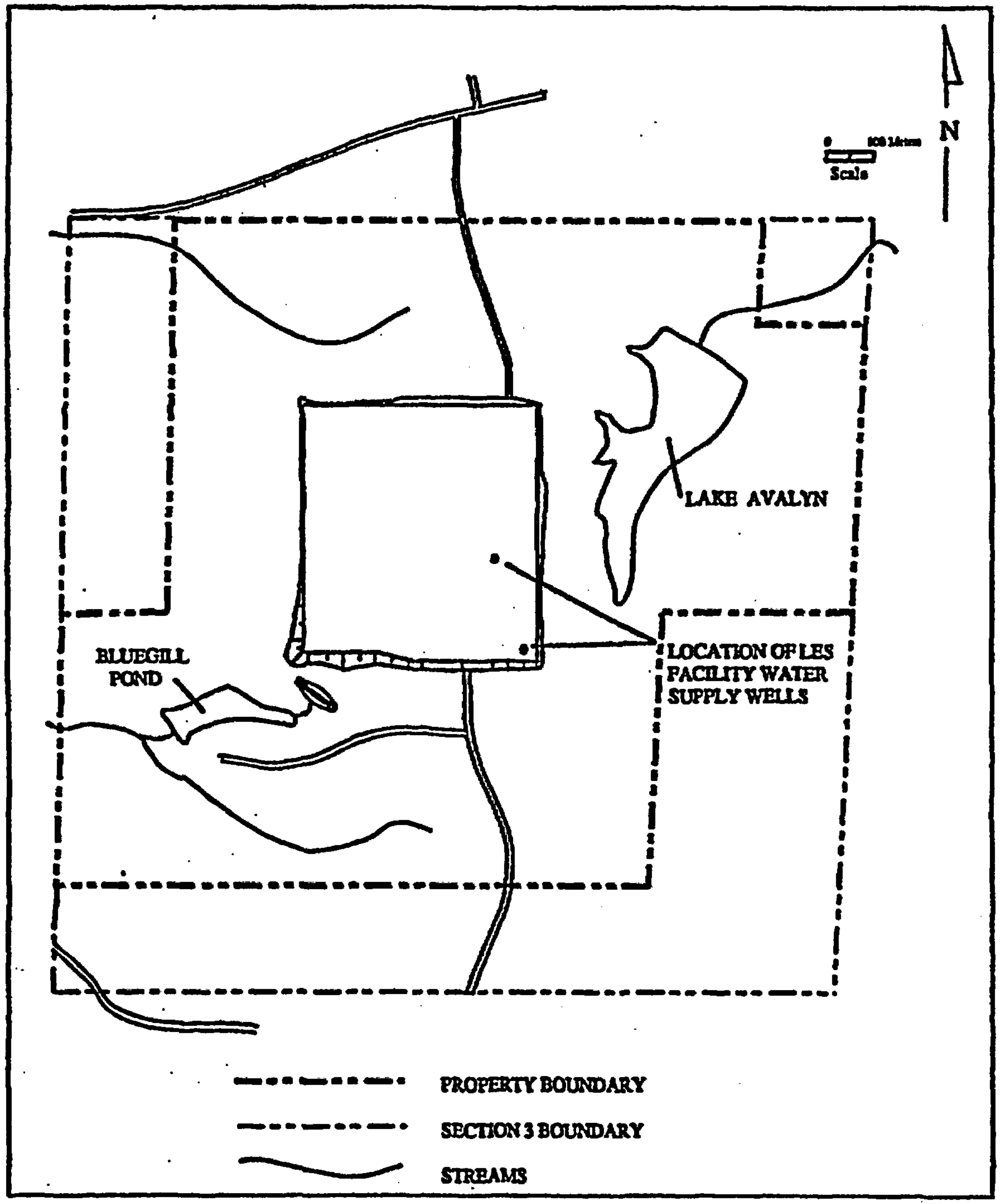

Figure 4.3 Location of the Water Supply Wells at CEC Site (Adapted from LES, 1994a).

Table 4.1 Volume of Site Soils to be Cut and Filled for the Construction of the CEC Facility (LES, 1994a)

Area	Volume m^3 (yd^3)	Type of Soil Movement
Facility Yard (Controlled Area)	306,073 (400,305)	Fill
	310,235 (405,749)	Excavation
Hold-Up Basin	21,409 (28,000)	Fill

If the volume of a fuel or oil spill is large enough, or if a spill occurs in close proximity to local surface water, it may migrate and contaminate groundwater or surface water. However, the quantity of hazardous liquid substances (such as fuel and oil) that will be stored or transported during site construction is not expected to be significant, and LES will have a spill contingency plan (LES, 1993a). CEC is expected to comply with the provisions of the EPA NPDES General Permits For Stormwater Discharges From Construction Sites (EPA, 1991).

The presence of high conductivity or preferential flow paths may increase the potential for contaminant migration to groundwater. Preferential flow paths at the CEC site include existing water wells, the installation of new monitoring and water supply wells, and desiccation cracks in soils with a high shrink-swell potential. Proper plugging and closure of wells will prevent direct contaminant flow to the shallow aquifer. Installing the water supply wells through the Cook Mountain confining layer also creates the potential for a direct hydraulic connection and contaminant migration pathway between the shallow aquifer and the deep Sparta Sand Aquifer. Preferential contaminant migration flow paths also may exist in the areas of the site covered with Sacul soils that have high shrink-swell capabilities. These soils swell when saturated and shrink when they dry, forming cracks that can provide pathways, possibly accelerating the infiltration of surface water to shallow groundwater.

As stated above, the quantities of potentially hazardous liquids stored and transported during construction are expected to be small. Spill contingency plans should prevent the migration of spills to shallow groundwater. Also, the possibility exists that the shallow groundwater underneath the site is not hydraulically connected outside the site boundaries. Thus, potential impacts can be prevented, contained, and mitigated.

4.1.2 Land Use

Construction of the proposed uranium enrichment facility will impact the existing land use in the immediate 28-hectare (70-acre) area of development. Impacts will occur through clearing, grubbing, excoriation, filling, grading, stock-piling, and building. The impacted area

consists primarily of recently clear-cut upland mixed forest. Approximately 20 hectares (49 acres) of upland mixed pine/hardwood forest were harvested in 1990 (LES, 1994a). The area currently consists of early regrowth vegetation such as grasses and shrubs, and some trees have begun to grow again in the area. The remaining 150 hectares (370 acres) of the proposed site will primarily remain in its natural state to serve as a buffer zone for the surrounding land uses (Figure 4.4). Overall land use impacts appear minimal given the current state of the environment at the site, the size of the facility relative to the buffer zone, and the historic uses of the area for logging and recreation. The anticipated effects on the soil during construction activities are limited to a potential short-term increase in soil erosion. This will be mitigated by proper construction techniques, such as immediate vegetation of exposed soils and proper grading.

4.1.3 Biotic Resources

During the site preparation and construction phase of the CEC facility, the vegetation community within the 28 hectares (70 acres) will be completely cleared. No chemicals will be used to control vegetation during this activity (LES, 1994a and 1993a). (The vegetation community species are given in Section 3.5.1 of this EIS.) The immediate area of impact constitutes approximately 16 percent of the total site. In addition, the stresses on the botanical community at the CEC site consist primarily of recent timbering. About 61 percent of the total land area of the site was timbered in 1989; approximately 94 percent of the total land area was cleared in the past 10 years (LES, 1994a). The young woody plants typical of the region are expected to reappear, such as sassafras, sweetgum, winged sumac, persimmon, and loblolly pine. In later stages, other commercially important timber species will dominate the forest, including maple, southern red oak, white oak, bitternut hickory, and black gum. Thus the siting of the CEC facility will have positive impacts on the botanical community beyond the immediate facility area due to the reforestation of the surrounding habitats.

The construction of the two 115-kilovolt (kV) transmission lines to the site from Haynesville and Bernice will require the clearing of about 144 hectares of land. These two right-of-way strips, which are more than 80 percent wooded land, will remain low-cut for maintenance of the lines. The displacement of terrestrial wildlife species inhabiting these lands creates little impact to the general population of the area.

The displacement of terrestrial wildlife species inhabiting the 28 hectares (70 acres) to be developed and the Hold-Up Basin area is negligible. For example, it is estimated by LES (1993b) that between 51 and 408 cottontail, 7 skunks, and 1 white-tail deer could be displaced by the construction of CEC. A variety of edge and scrub-shrub avians such as the song sparrow, rufous-sided towhee, and American goldfinch might be displaced. This displacement potential is not likely to cause any significant impacts to the wildlife community. The permanent displacement of the 28 hectares (70 acres) of forest habitat would be substituted by the regrowth of the surrounding prevalent forest habitats in other portions of the site. Smaller species, such as the five-lined skunk, ground skunk, and six-line

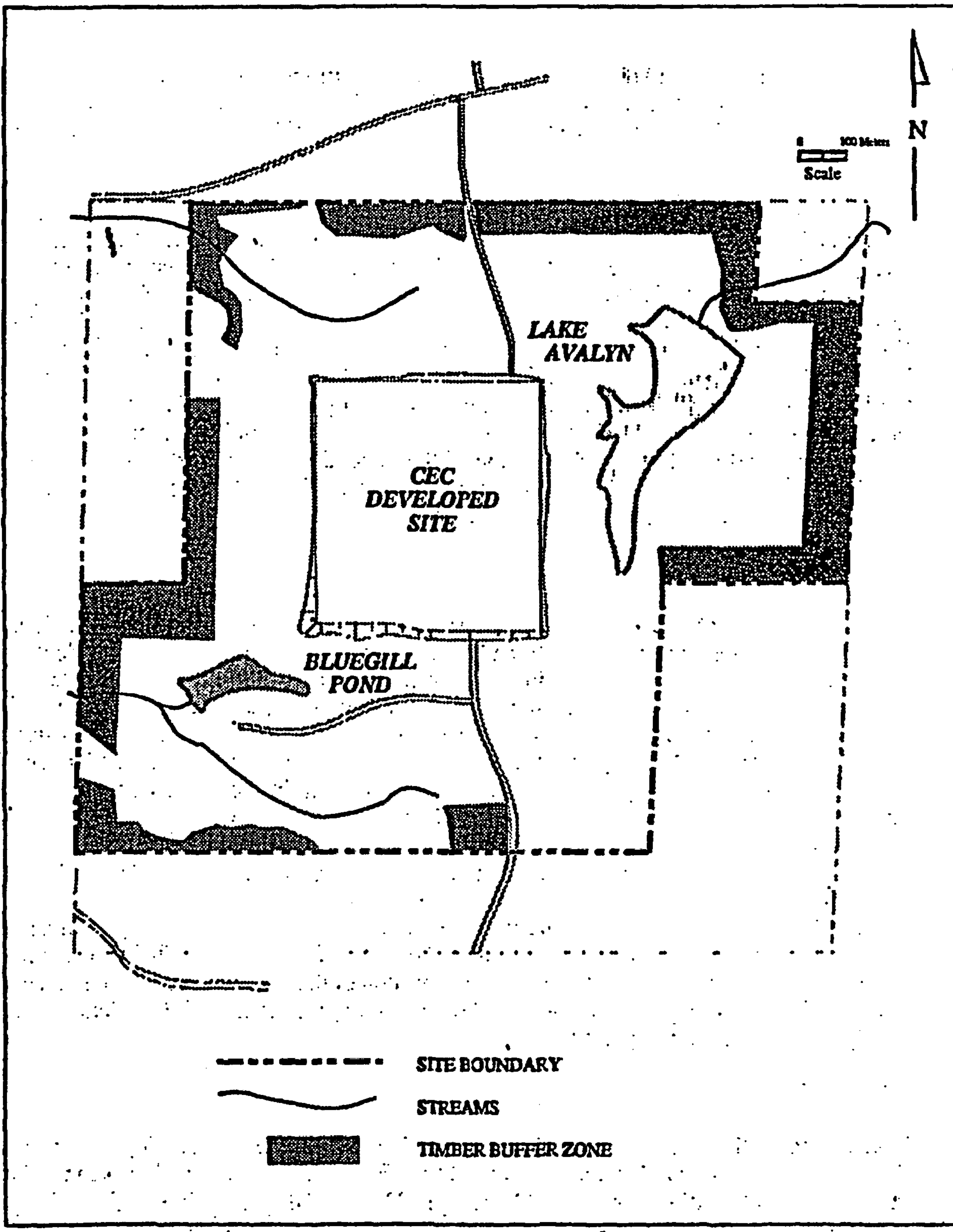

Figure 4.4 Schematic Delineation of the Timber Buffer Zone

racerunner could be killed by operating machinery and increased traffic; however, this would not lead to significant impacts to the wildlife populations for the long term. General disruption of wildlife species in the area would be negligible and is likely to have only temporary impacts.

The recharge alterations of annual runoffs to Lake Avalyn and Bluegill Pond and the likely changes of water chemistry are expected to affect the aquatic species diversity structure on a very small scale. The majority of the aquatic species living in these two manmade water bodies are tolerant species such as carp, catfish, sunfish, and bullheads. Others may tend to avoid areas exposed to temporary increases in turbidity. LES plans to develop an Erosion Control Plan for implementation prior to site clearing activities. The implementation of this plan will minimize turbidity and siltation potentials. Excavation for the Hold-Up Basin will result in the creation of about one hectare of new closed surface water habitat limited to a few species such as insects, amphibians, and other small invertebrates and plankton. The creation of the Hold-Up Basin would provide terrestrial wildlife species with additional drinking water sources; it would also provide breeding habitat for many of the resident aquatic species.

4.1.4 Noise

The construction of the facility will require the use of large earth-moving equipment, compressors, and generators. Additionally, increased truck and light vehicle traffic flow on roads and highways in the area will result in increased noise. The noise onsite during construction may also be loud and annoying. As shown in Table 3.46, construction noise is generally around 110 dB. Noise will mostly affect a one-mile radius. Someone outside the nearest residence to the site, about 380 meters (1,250 feet) away, is estimated to receive about a 70 dB impact from the construction activities within the fenced area of the site. Higher noise levels for a shorter period of time will be caused by road construction and other short-term construction activities nearer to the residence. This level is similar to the level that will be generated by traffic coming and going from the site on Parish Road 39.

The level of noise anticipated offsite is comparable to noise levels by a busy road and less than noise levels found in most city neighborhoods. However, it will be a noticeable increase over existing local noise levels. The duration of the noise will be limited to daylight hours during the period of construction. Proper safety precautions will be taken to protect the hearing of workers at the site.

4.1.5 Traffic

LES estimates that an average of 275 construction workers will be employed at any time during the peak construction period (Years 2-5) (LES, 1994a), with a maximum in the fourth year of 400. Operations workers will average 180, once full production begins. The peak year for combined site personnel is Year 4, with 400 construction workers and 145 operations personnel, totaling 545. This represents an average increase of 545 one-way trips

daily, assuming each worker makes one round trip per day and brings his or her lunch. A maximum of 1,090 trips per day is expected. This number may increase slightly if restaurants and hardware and supply stores are convenient. The number of daily trips estimated for trucks bringing construction materials and supplies, as well as heavy trucks, was detailed in Section 2 of this document.

To calculate traffic-related impacts, it is assumed that as many as two-thirds of CEC employees will be relocated from outside the area. It is further assumed that each worker commutes 12,000 miles annually and that 10,000 of those miles are driven in local parishes (an average 21-mile commute). Based on these assumptions, the number of traffic-related injuries and deaths would be as shown in Table 4.2. The injury and death rates are based on 1992 Claiborne Parish accident data obtained from the state of Louisiana (Magri, 1994) and presented in Table 4.3.

Table 4.2 The Annual Impact of Increased Automotive Traffic

Year	Incremental Vehicle Miles (in Millions)	Increase in Vehicle-Related Injuries	Increase in Vehicle-Related Deaths
1	1.0	1.01	0.02
2	2.8	2.76	0.07
3	6.3	6.11	0.08
4	8.0	4.73	0.14
5	6.4	6.24	0.18
6	4.2	4.05	0.15
7 and beyond	2.4	2.33	0.06

Table 4.3 1992 Traffic Accident Statistics for Claiborne Parish

Location	Total Accidents	Fatalities	Injuries
Rural	80	4	121
Haynesville	19	0	30
Homer	4	0	4
Not Found	3	0	11
Parish Totals	106	4	166

It is estimated that 22 to 43 round trips (up to 86 one-way trips) will be made by commercial trucks each day. These trucks will come from local and regional contractor vendors who are accustomed to providing construction supplies and services. It is estimated that 20 percent of the trucks come from as far as Shreveport (80 km), 30 percent come from outside Claiborne Parish (40 km) and 50 percent come from either Homer or inside the Parish (10 km). The construction-related truck transportation would potentially cause 2.6 injuries and no fatalities annually (Wolff, 1984).

This truck count, combining with workers' vehicles, will increase peak traffic counts by 1,176 vehicles per day; and will result in a substantial increase in the daily traffic flow along road LA 9, with traffic increasing from 1,770 to nearly 3,000 vehicles per day. This amount of increased traffic on a road would not be noticeable if distributed throughout the day. The total traffic count, although a significant increase in traffic locally, is actually comparable to current levels in some sections of road LA 9 in the parish. However, the rush periods at the site may cause tie-ups and minor delays if LES does not stagger arrival and departure times during the peak construction phase (the third and fourth years after breaking ground). If all the workers arrive within a 15-minute span of time, a vehicle would in effect be added about every 1.65 seconds to the existing morning and evening "rush hours." This may reduce the average speed on the road slightly during those time periods. The increase in traffic and the large number of very large vehicles may also cause an increase in the rate of road maintenance requirements. Potholes will occur more frequently than before on roadways receiving much of the truck traffic.

Parish Road 39 is to be relocated to the west of the CEC site, requiring the allocation of nearly 6 hectares of timberland. The relocation effort will be executed by the Claiborne Parish Police Jury. The Claiborne Parish Police Jury passed a resolution in November 1989 stating that the Parish would authorize and work with LES on the relocation of Route 39 if necessary for the construction of CEC. The Policy Jury has the authority to relocate Parish roads (Hardy, 1994).

The relocation of Parish Road 39 will add approximately 120 meters (0.075 mile) to the traveling distance between LA2 and LA9. This increase would use a very small amount of fuel. Communities located on Parish Road 39, such as those near Forest Grove Church south of the site and near Center Springs Church north of CEC, may incur an additional 600 meters (0.38 mile) to commute between the two churches. This additional 600 meters of driving would require a total extra 0.15 liter (0.04 gallon) of gasoline per trip. For residents immediately south of the southern site boundary traveling to the northern site boundary, a maximum distance of about 3,200 meters (2 miles) is estimated, incurring approximately 0.76 liter (0.2 gallon) of extra fuel per trip. Since Homer, the largest nearby town, is located to the west, it is conservative to assume that 50 percent of the local traffic goes each way. Therefore, this road modification adds, on the average, less than a minute to travel times and less than one expected injury every 10,000 years, according to Department of Transportation (DOT) accident data published in SAND84-0062 (Wolff, 1984). NRC staff concludes that these potential impacts associated with the relocation of

Parish Road 39 are very small and would not impose unacceptable risks to the local community or harm to the environment.

4.1.6 Air Pollution

During the construction phase of the project, fugitive emissions will be comprised mainly of dust and vehicle emissions. Details of calculation methodology and assumptions are provided in the applicant's Environmental Report (LES, 1994a). Fugitive dust will occur due to construction and the initial clearing of 28 hectares (70 acres). Vehicle traffic on unpaved surfaces, earthmoving, excavating, bulldozing, and wind erosion will be the major sources of dust. The first 5 months of earthwork will likely be the period of highest emissions because the greatest number of construction vehicles will be operating on all 28 hectares (70 acres) of unprepared surface. Dust generation will be suppressed by watering, revegetation of bare areas, covering open trucks carrying dusty material, removing dirt and debris from the road surface, and using containment methods whenever feasible.

Emissions from worker commuter vehicles were independently estimated by the NRC staff based on the assumption that a maximum of 1,090 automobiles (2 cars per employee) would be added to the area, also considering delivery trucks. The following percentages of automobiles are assumed to apply for these types of activities: 80.4 percent automobiles, 11.8 percent light duty trucks, 4.6 percent heavy duty trucks, 3.2 percent heavy duty diesel trucks. It was further assumed that two-thirds of the automobiles would be comparable to the 1990 emission factor, and one-third would compare to the 1985 emission factor. Annual emission estimates due to the increased traffic of the peak year and their relevance to the EPA National Ambient Air Quality Standards (NAAQS) *de minimis* levels are presented in Table 4.4. This comparison demonstrates that the emissions are below the *de minimis* levels. Emissions below the EPA *de minimis* levels are not considered significant for further assessment or control.

Table 4.4 Estimated Commuter and Delivery Vehicle Emissions for Year 4

Pollutant	Emission Factor (g/km)	Total Emissions (metric tons/yr)	*De Minimis* Levels (metric tons/yr)
CO	7.93	63	91
HC	1.35	11	36
NO_x	1.32	11	36
SO_x	0.12	1	36
TSP	0.25	2	23

Vehicle emissions are also caused by support and construction vehicles. Predicted support vehicle emissions are given in Table 4.5. Emission factors used in determining the emission rates for onsite construction, provided by the LES based on EPA factors, are given in Table 4.6 (LES, 1994a). Predicted construction vehicle emissions are given in Table 4.7, assuming that all equipment will be running simultaneously. Projected vehicular peak emission rates and fugitive particulate emissions are shown in Table 4.8, along with LES estimates of fugitive particulate emissions from site preparation activities (LES, 1994a). These rates, outlined by Table 4.8, are multiplied by the maximum predicted site boundary concentrations normalized to a 1.0 g/sec emission rate (Table 4.9), and the predicted site boundary maximum air concentrations of dust and vehicle emissions are shown in Table 4.10. The maximum predicted air concentrations at the site boundary for the various averaging periods were compared to applicable NAAQS. Emissions were assumed to be produced 10 hours per day, 5 days per week, 50 weeks per year, over the entire 28-hectare (70-acre) site. The resulting predicted concentrations are well below the applicable NAAQS for particulates (Table 4.10).

No NAAQS have been set for hydrocarbons; however, the total annual emissions of hydrocarbons predicted from the site are approximately 13,450 kg (14.7 tons), well below the 36,280-kg (40-ton) level that is defined by EPA as a significant source of volatile organic compounds (VOCs). Air concentrations of the criteria pollutants predicted for vehicle emissions are all at least an order of magnitude below the NAAQS. Therefore, the potential emissions are considered to have very small impact. Variation in emissions related to the seasonal change in gasoline due to Reid Vapor Pressure would not alter the conclusion of minimal impact.

Onsite vehicle refueling will also cause emissions, but these have been included in the hydrocarbon emission rates. EPA includes the vapors emitted during refueling in the emission factor for non-methane hydrocarbons; therefore, no separate emission estimates are needed. EPA does not include diesel refueling emissions in the emission factors for non-methane hydrocarbons since the low volatility of diesel fuel makes these emissions relatively insignificant.

The Occupational Safety and Health Act (OSHA) and the Clean Air Act (CAA) have similar requirements for controlling sudden and unexpected releases of toxic chemicals that may be gaseous or readily form vapors. Compliance with these regulations will reduce the risk of a release of any type of harmful gas.

Table 4.10 demonstrates that if the emissions came from a point source, it would not be significant enough to trigger prevention of significant deterioration (PSD) permit requirements. Actual increases in emissions would exceed predictions because of multiple uses of cars driven by family members and new residents taking advantage of the area's expanding economy. However, because the emissions will be spread over a very large area, the impact on air quality should be small.

Table 4.5 Predicted Support Vehicle Emissions (LES, 1994a)

Vehicle	Emission Factor (g/km)	Number of Vehicles	Daily Mileage (km)	Daily Emissions (g)	Workday Average Emission Rate (g/s)
Nonmethane Hydrocarbons:					
Light Duty Truck I	1.0	3	16	48	0.00133
Light Duty Truck II	1.06	1	16	17	0.00047
Heavy Duty Truck	2.3	1	16	37	0.00103
Total				102	0.00283
Carbon Monoxide:					
Light Duty Truck I	5.1	3	16	246	0.00683
Light Duty Truck II	5.3	1	16	85	0.00236
Heavy Duty Truck	20.7	1	16	331	0.00919
Total				662	0.01838
Nitrogen Oxides:					
Light Duty Truck I	0.6	3	16	30	0.00083
Light Duty Truck II	0.6	1	16	10	0.00028
Heavy Duty Truck	1.9	1	16	30	0.00083
Total				70	0.00194

Additional emissions will be caused by home heating, use of paints and thinners, aerosols, and other area source emissions. These emissions, considered minor contributors, are not included since automobiles create the most emissions. During the winter season, CO causes pollutant problems normally associated with crowded streets and parking garages due primarily to cold air that lowers the combustion chamber temperature. However, this would not be a pollutant problem in rural settings or where emissions will be distributed over large areas, as is the case here. The primary smog-forming pollutants HC and NO_x, associated with air inversions during warm weather, would potentially be of concern in the area, particularly since emissions of HC from residential and commercial sources are more significant than emissions of other pollutants. The quantities of TSP and SO_x emitted are not considered to be a potential problem.

Table 4.6 EPA Based Construction Emission Factors Per Vehicle (LES, 1994a)

Equipment	Workday Average Emission Rates (g/hr)				
	Exhaust Hydrocarbons	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulates
Wheeled Tractor	85.26	1622.77	575.84	40.9	61.5
Scraper	128.15	586.17	1740.74	210	184
Grader	18.07	68.46	324.43	39	27.7
Wheeled Loader	113.17	259.58	858.19	82.5	77.9
Track-Type Loader	44.55	91.15	375.22	34.4	26.4
Off-Road Truck	86.84	816.81	1889.16	206	116
Roller	30.58	137.97	392.9	30.5	22.7
Miscellaneous	69.35	306.37	767.3	64.7	63.2

Table 4.7 Equipment Inventory and Predicted Total Peak Emission Rates for Construction Vehicles (LES, 1994a)

Equipment	Numbers	Workday Average Emission Rates (g/s)				
		Exhaust Hydrocarbons	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulates
Wheeled Tractor	1	0.024	0.451	0.160	0.011	0.017
Scraper	4	0.142	0.651	1.934	0.233	0.204
Grader	1	0.005	0.019	0.090	0.011	0.008
Wheeled Loader	2	0.063	0.144	0.477	0.046	0.043
Track-Type Loader	5	0.062	0.127	0.521	0.048	0.037
Off-Road Truck	5	0.121	1.135	2.624	0.286	0.161
Roller	3	0.025	0.115	0.327	0.025	0.019
Miscellaneous	1	0.019	0.085	0.213	0.018	0.018
Total		0.461	2.725	6.346	0.678	0.507

4.1.7 Socioeconomic and Community Support Services

During the construction phase, the CEC plant will employ a peak construction work force of about 400 persons, with an annual average of about 200 over the 6-year construction

Table 4.8 Predicted Peak Emission Rates (LES, 1994a)

Pollutant	Total Workday Average Emissions (g/s)
Vehicle Emissions:	
Hydrocarbons	0.461
Carbon Monoxide	2.73
Nitrogen Oxides	6.35
Sulfur Oxides	0.678
Particulates	0.507
Fugitive Emissions:	
Particulates	5.8

Table 4.9 Maximum Predicted Site Boundary Air Concentrations Based on a 1.0 g/sec Emission Rate (LES, 1994a)

Averaging Time	Maximum Air Concentration ($\mu g/m^3$)	Direction from Site
1 Hour	91.8	Southeast
3 Hours	38.3	Northeast
8 Hours	25.1	West
Highest 24 Hours	12.6	West
2nd Highest 24 Hours	11.4	West
1 Year	1.32	North

period and 275 over the 4 middle years of construction. LES estimates that these jobs will pay an average of $37,000/year, including benefits (LES, 1992h), as compared to an area average of $19,685/year and a national average of $23,348/year for all jobs.

LES has defined a 24-parish labor pool comprising all workers within about 2 hours commuting time (LES, 1994a). While it is probable that a high percentage (perhaps 85 percent) of the construction workers will ultimately reside in the 24-parish labor pool, these workers do not necessarily reside in the area now. During the construction phase, a significant but difficult-to-quantify number of workers will come from outside the area (Michael, 1992). These workers will be drawn by the high wages offered at the facility and the depressed state of the construction labor market in the multi-state region which includes Louisiana.

Table 4.10 Predicted Property Boundary Air Concentrations Compared to Applicable NAAQS (LES, 1993b)

	Maximum 1-Hour Average (μg/m³)		Maximum 3-Hour Average (μg/m³)		Maximum 8-Hour Average (μg/m³)		Maximum 24-Hour Average (μg/m³)		2nd Highest 24-Hour Average (μg/m³)		Maximum Annual Average (μg/m³)	
Pollutant	Predicted	NAAQS	Predicted	NAAQS	Predicted	NAAQS	Predicted	NAAQS	Predicted	NAAQS	Predicted	NAAQS
VEHICLE EMISSIONS												
Hydrocarbons	42.3		17		12		6.0		5.26		0.608	
Carbon Monoxide	250	40,000	105		69	10,000	36.4		31.1		3.61	
Nitrogen Oxides	583		243		159		80.0		72.4		8.38	100
Sulfur Oxides	16.1		6.7	1310(a)	4		2.2	365	2.00		0.231	80
Particulates	62.2		26		17		9.0		7.73	150	0.895	50
FUGITIVE DUST												
Particulates	532		221		146		73		66.1	150	7.66	50

(a) Secondary standard

There is evidence that suggests that as many as one-half to two-thirds of incremental construction job opportunities are filled by migrants (i.e., out-of-area individuals) (Greenwood et al., 1986). Impacts on rural areas from large-scale construction projects tend to be at the upper end of that range or higher. The existence of the pool of workers in the 24-parish region implies a large source of potential construction labor, but these workers will compete with equally qualified workers willing to migrate from other regions. Section 4.5.4 discusses LES' plans to hire existing residents of the Parish and certain other groups of people in accordance with the Louisiana Enterprise Zone Act.

The ultimate residence of incoming migrants within the 24-parish region is likely to depend on amenities. A review of the amenities in the region suggests that workers are likely to migrate to one of the large parishes and commute to Claiborne Parish.

For quantification purposes, this analysis estimates that 40 percent of the workers will be drawn from outside LES' self-defined 24-parish region based on a 2-hour commuting time, and 60 percent will be drawn from within the region. Ultimately, 85 percent will live within the 24-parish region, thus generating income and tax revenues for these parishes and constituting positive socioeconomic impacts on the region. Hiring in accordance with the Louisiana Enterprise Zone Act will also provide socioeconomic benefits within the region.

The existing large pool of qualified heavy construction workers available throughout the labor pool will require very little training. The relatively small and temporary influx of labor during the CEC construction period is not expected to strain community services and facilities, except possibly the police force. The Homer Police Department may be temporarily strained by the influx of transient workers and other factors (see Section 4.2.1.7.1). Increases in the police force and some community support services, such as job training, may be necessary to satisfy the demand of local residents and to control potential increases in crime. However, the local fire and police departments will not be significantly affected by activities on LES' site since CEC will provide its own fire protection system and security staff during construction and operation (LES, 1994a). Impacts on the real estate market are expected to be minimal. The potential impacts of the construction phase on hospitals will be limited, as minor work-related illnesses or accidents will be treated at the site.

4.2 Operation

This section assesses the impacts from the operation of CEC under both normal conditions and postulated accident conditions. This section also analyzes the potential impacts from transportation activities associated with CEC operations.

The operation of the CEC facility creates the potential for radiological and nonradiological impacts. CEC, however, has incorporated selected features and designs to minimize gaseous and liquid effluent releases and to keep them within regulatory limits (LES, 1994a). These designs include:

a. The process systems which handle UF_6 operate almost entirely at subatmospheric pressures. Such operation minimizes outward leakage of UF_6.

b. The one location where UF_6 pressure is raised above atmospheric pressure is in the piping and cylinders inside the autoclaves. The pressure is still low (179,900 pascals or 26.1 psia). The piping and cylinders inside the autoclaves confine the UF_6. In the event of leakage, the autoclave provides secondary containment of UF_6. In addition, the higher pressure piping also is separated from the remainder of the piping by a fail-closed valve.

c. Cylinders of UF_6 are moved only when cool and when the UF_6 is in solid form. This minimizes the risk of inadvertent release due to mishandling.

d. Process off-gas, from UF_6 purification and other operations, is passed through desublimers to solidify and reclaim as much UF_6 as possible prior to discharge. Remaining gases are discharged through high-efficiency filters and chemical adsorbent beds. The filters and adsorbents remove HF and uranium compounds left in the gaseous effluent stream.

e. Liquids and equipment that come in contact with uranium compounds in the process systems may become contaminated. When these liquids and solids (e.g., oils, damaged piping, or equipment) are removed for cleaning or maintenance, portions end up in wastes and effluent. Different processes are employed to separate uranium compounds and other materials (such as various heavy metals) from the resulting wastes and effluent.

f. Control of wastes and effluents is accomplished by liquid and solid waste handling systems and techniques, which are described in detail in the LES ER (1994a). In general, basic principles for waste handling are followed in all of the systems and processes. Different waste types are collected in separate containers to minimize contamination of one waste type with another. Materials which can cause airborne contamination are carefully packaged; ventilation and filtration of the air in the area is provided as necessary. Liquid wastes are confined to piping, tanks, and other containers; curbing, pits, and sumps are used to collect and contain leaks and spills. Hazardous wastes are stored in designated areas in carefully labeled containers; mixed wastes are also contained and stored separately. Mixed wastes will not be stored onsite for more than 90 days; therefore, no mixed waste storage permit will be required. Strong acids and caustics are neutralized before entering the effluent stream. Radioactively contaminated wastes are decontaminated insofar as possible to reduce waste volume.

g. Following handling and treatment processes to limit wastes and effluent, sampling and monitoring is performed to assure regulatory limits are not exceeded in effluent streams. Gaseous effluent is monitored before release. Liquid effluent is sampled

and/or monitored in liquid waste and sewage treatment systems prior to release. Solid wastes are sampled and/or monitored prior to offsite treatment and disposal. Samples are returned to their source where feasible to minimize input to waste streams.

4.2.1 Nonradiological Impacts

This section discusses the main nonradiological impacts on the community from CEC facility operations. Areas considered are hydrology, land use, biotic resources, noise, air quality, traffic, socioeconomic, community support, and transportation.

4.2.1.1 Hydrology

The operation of the CEC facility creates the potential for nonradiological environmental impacts to the site hydrology. These impacts include changes in the amount and flow direction of surface water, changes in the elevation and flow direction of groundwater, and contaminant releases of nonradiological substances to surface water and groundwater.

Section 4.1 discussed how construction of the CEC facility will result in changes in the drainage area of both the Lake Avalyn and Bluegill Pond basins. The facility foundation, tails storage yards, and parking lots will be constructed on the drainage divide between the Bluegill Pond Drainage Basin and the Lake Avalyn Drainage Basin (Figure 4.1). All precipitation falling on these areas during facility operation will be routed to one outfall and discharged to the Hold-Up Basin. Therefore, surface runoff from the portion of the Lake Avalyn drainage area that is covered by the facility will be directed to Bluegill Pond. As a result, water levels in the Lake Avalyn basin will likely be lower during plant operation, due to this decrease in drainage area. This would contribute to the reduction of Lake Avalyn surface area and probable slight increase in the total dissolved solids. On the other hand, the sediments load to the lake would decrease. In balance, however, these charges would not significantly affect the uses of the lake and its productivity. Annual runoff to Lake Avalyn may decrease by as much as 20 percent due to the presence of the CEC facility (LES, 1994a).

Operation of the CEC also will result in an increase of surface water discharge to Bluegill Pond. LES estimates that approximately 380,000 m^3 (100 million gallons) of surface runoff would be discharged from the yard drain system annually (LES, 1994a). In addition to this capture of surface water, groundwater pumped from the Sparta Sand Aquifer will be used for facility operation. After use, the wastewater will be treated and discharged. This treated wastewater will result in an additional 9,460 m^3 (2,500,000 gallons) of discharge annually to Bluegill Pond. The total estimated amount of liquid effluent and stormwater discharged to the Bluegill Pond drainage is approximately 389,500 m^3/yr (102,500,000 gal/yr). The current average flow rate of the stream that flows from Bluegill Pond is about 286,000 m^3/year (LES, 1994a). The flow in this stream currently is intermittent in nature (section 3.3.1) and the expected increased average flow resulting from the operation of the CEC facility is

about 7 l/sec greater than the highest flow rate of 19 l/sec measured in January 1990 (Table 3.6). This slight increase in average flow will likely result in a decrease in the intermittent nature of the stream, particularly in dry seasons. This increase in discharge will not affect the level of Bluegill Pond because the water level is controlled by the height of the earthen dam that forms the pond.

The operation of the facility may result in changes in the elevation of the shallow and deep aquifers beneath the site. These changes will be caused by both a combination of decreased groundwater recharge beneath facility buildings, storage yards, and parking lots and by the withdrawal of groundwater for use by the CEC facility.

Decreased infiltration of precipitation and groundwater recharge will result from the existence of impermeable surfaces (e.g., parking lots, storage yards, and building roofs) and from the routing of runoff from these surfaces to the Bluegill Pond drainage area. This decrease in infiltration to the shallow aquifer will result in a lowering of the shallow water table directly beneath the site. This effect should not be observed beyond the site boundaries and will not adversely impact domestic production in offsite wells.

Changes in the Sparta Sand Aquifer can be expected to occur as a result of groundwater withdrawal for facility use. The CEC facility intends to install two water supply wells onsite (Figure 4.3). These wells will be installed and screened in the Sparta Sand Aquifer at depths of 120 m (394 ft) below sea level or 213.5 m (700 ft) below land surface (LES, 1994a). Pumping rates for these two wells are expected to average 27 m^3/day (5 gpm) with a maximum of 82 m^3/day (15 gpm). The pumping of groundwater from these two wells creates the potential for lowering the elevation of the potentiometric surface of the Sparta Sand Aquifer. Specifically, pumping of these two wells will likely result in a cone of depression in the water table in the immediate vicinity of the wells. LES performed an evaluation of the magnitude of the drawdown expected to occur as a result of withdrawal of groundwater from these two wells. LES estimates that the pumping of the water supply wells at the site will not be continuous. Instead, the withdrawal wells will be pumped periodically to fill water storage tanks. However, to conservatively calculate aquifer drawdown over time, calculations were performed for the aquifer based on continuous pumping for a period of 30 years. Potential drawdown was also calculated based on combined pumping rates of 27 m^3/day, 82 m^3/day, and 273 m^3/day (5, 15, and 50 gpm) for the two wells. The 273 m^3/day rate reflects the maximum rate of the well pumps. The calculated drawdown of the Sparta Sand Aquifer for each scenario is provided in Table 4.11.

Based on the available information, the Sparta Sand Aquifer will experience a decrease in elevation as a result of pumping at site water supply wells. This decrease is expected to range from 0.03 to 1.2 m (0.1 to 4 ft) for a 30-year pumping scenario, depending on the assumed pumping rates and aquifer transmissivities. Drawdown in the Sparta Sand Aquifer produced by the facility pumping wells is compared to drawdown caused by the nearest drinking water well (the Central Claiborne Water System Well No. 4). Using the minimum pumping rate for the site water supply wells of 30 m^3/day (5 gpm), drawdown at the point

Table 4.11 Calculated Drawdown from the Offsite Claiborne Well No. 4 and the Onsite LES Water Supply Wells (LES, 1994a)

	Drawdown in Meters (feet)		
	Claiborne Well No. 4	LES Wells	Total
Pumping Rate = 27 m^3/day (5 gpm) **Aquifer Transmissivity = 15,000 gpd/ft**			
At the Southern LES Property Boundary (1)	1.08 (3.53)	0.13 (0.43)	1.21 (3.96)
At a Point Between the Wells (2)	1.25 (4.11)	0.10 (0.34)	1.36 (4.45)
At Claiborne Well No. 4 (3)	3.45 (11.31)	0.09 (0.30)	3.54 (11.61)
Aquifer Transmissivity = 75,000 gpd/ft			
At the Southern Property Boundary (1)	0.26 (0.84)	0.03 (0.10)	0.29 (0.94)
At a Point Between the Wells (2)	0.29 (0.96)	0.02 (0.08)	0.32 (1.04)
At Claiborne Well No. 4 (3)	0.73 (2.40)	0.02 (0.07)	0.75 (2.47)
Pumping Rate = 82 m^3/day (15 gpm) **Aquifer Transmissivity = 15,000 gpd/ft**			
At the Southern LES Property Boundary (1)	1.08 (3.53)	0.39 (1.28)	1.47 (4.81)
At a Point Between the Wells (2)	1.25 (4.11)	0.31 (1.03)	1.57 (5.14)
At Claiborne Well No. 4 (3)	3.45 (11.31)	0.28 (0.91)	3.72 (12.22)
Aquifer Transmissivity = 75,000 gpd/ft			
At the Southern LES Property Boundary (1)	0.26 (0.84)	0.09 (0.29)	0.34 (1.13)
At a Point Between the Wells (2)	0.29 (0.96)	0.07 (0.24)	0.37 (1.20)
At Claiborne Well No. 4 (3)	0.73 (2.40)	0.07 (0.22)	0.8 (2.62)
Pumping Rate = 273 m^3/day (50 gpm) **Aquifer Transmissivity = 15,000 gpd/ft**			
At the Southern LES Property Boundary (1)	1.08 (3.53)	1.3 (4.27)	2.38 (7.80)
At a Point Between the Wells (2)	1.25 (4.11)	1.05 (3.43)	2.30 (7.54)
At Claiborne Well No. 4 (3)	3.45 (11.31)	0.93 (3.04)	4.37 (14.35)
Aquifer Transmissivity = 75,000 gpd/ft			
At the Southern LES Property Boundary (1)	0.26 (0.84)	0.3 (0.98)	0.55 (1.82)
At a Point Between the Wells (2)	0.29 (0.96)	0.25 (0.81)	0.54 (1.77)
At Claiborne Well No. 4 (3)	0.73 (2.40)	0.22 (0.73)	0.95 (3.13)

(1) Approximately 0.8 km (.5 mile) from the location of the LES water supply wells.
(2) Approximately 2.4 km (1.5 miles) from the location of the LES water supply wells.
(3) Approximately 4.0 km (2.5 miles) from the location of the LES water supply wells.

closest to the pumping wells is approximately 10 to 12 percent of the drawdown caused by the Central Claiborne Water System Well No. 4. At the maximum pumping rate of 270 m^3/day (50 gpm), the drawdown from the site well and the Central Claiborne Water System Well No. 4 (LES, 1994a) is approximately equal. While this drawdown is significant with respect to the drawdown caused by the Claiborne public water supply Well No. 4, it is not likely to have an effect on public water supply wells using the deep Sparta Sand Aquifer in the vicinity. This drawdown is not significant with respect to the thickness of the sand layer that comprises the Sparta Aquifer, which is between 30.5 and 91.5m (100 and 300 ft) in thickness (LES, 1994a). The NRC staff concludes that water pumping at the site will not have a significant adverse impact on local water supply and wells.

The operation of the CEC facility creates the potential for releases of chemicals to surface water and groundwater. The sources of these potential contaminant releases are the discharge of treated wastewater and facility surface water runoff; the handling and storage of fuel, oil, and other hazardous chemicals; and the deposition of airborne contaminants.

Water that is used by the facility for normal operations (i.e., sanitation, laundry, equipment cleaning, etc.) will be treated before discharge by the facility sewage treatment system. Treated wastewater will be discharged through an approved National Pollutant Discharge Elimination System (NPDES) and LDEQ Wastewater Discharge Permit outfall (LES, 1992e). CEC is expected to comply with the requirements of these permits. The potential exists for this discharged water to become contaminated with hazardous substances released during the operation of the site. Surface water runoff from precipitation events will drain from the tails storage area and other portions of the site and will be discharged to the Hold-Up Basin.

Parking lot runoff may contain oil and grease that leaks or drips from facility vehicles. Discharges from the sewage treatment system and yard drains runoff will be monitored to detect any potential release of contaminants in liquid effluents to surface water. The potential also exists for the sediments to become contaminated. Contaminated sediments could serve as a secondary source of surface water contamination. The effluent monitoring programs are described in Chapter 5. The expected concentrations of each nonradiological pollutant that will be discharged are listed in Table 4.12. The discharge limits listed in the table are those expected in the LDEQ Permit, actual numbers could vary.

Calculations were performed to compute a conservative estimate of the amount of dilution that may be expected to occur for nonradiological pollutants in Bluegill Pond. These calculations do not account for various physical, chemical, and biological processes, such as mixing, absorption, and evaporation, that may affect the actual concentrations. A conservative value of the total expected outflow from Bluegill Pond was based on measured

low-flow values reported by LES and the total volume of treated effluent and runoff from the Yard Drains System:

Current Outflow from Bluegill Pond[a]	446,500 m^3/yr
Volume of Effluent Discharged from Facility[b]	389,500 m^3/yr
Total Outflow from Bluegill Pond	836,000 m^3/yr

a - Reported minimum discharge from Bluegill Pond measured in May 1990, of 14 l/sec (0.5 ft^3/sec) (LES, 1994a).
b - Includes total discharge of yard drains from Hold-Up Basin and total discharge from NPDES outfall to Bluegill Pond (LES 1993a).

Table 4.12 Expected Concentrations of Nonradiological Pollutants Discharged to Bluegill Pond

Parameter	Maximum Daily Values[a]	Concentration in Bluegill Pond with Dilution Factor of 2.1	Expected Regulatory Limits in the Discharge Permits
pH	6.5	NA[b]	6-8.5
BOD	30 mg/l	14.3 mg/l	45 mg/l
COD	70 mg/l	33.3 mg/l	NA
TOC	15 mg/l	7.1 mg/l	50 mg/l
TSS	5 mg/l	2.4 mg/l	20 mg/l
Ammonia	5 mg/l	2.4 mg/l	5 mg/l
Carbon Tetrachloride	0.001 ug/l	0.0005 μg/l	0.22 ug/l
Total Residual Chlorine	0.9 mg/l	0.4 mg/l	2 mg/l
Fecal Coliform	15/100 ml	7.1/100 ml	200/100 ml
Fluorides	<5 mg/l	<2.4 mg/l	1.0 mg/l
Sulfates	15 mg/l	7.1 mg/l	250 mg/l[c]
Oil/Grease	0.05 mg/l	0.02 mg/l	10 mg/l
Aluminum, Total	<0.1 mg/l	0.05 mg/l	Not Available
Lead	<1.5 ug/l	0.7 ug/l	1.3 ug/l
Mercury	<0.003 ug/l	0.0014 ug/l	0.012 ug/l

a - LES (1992e).
b - pH will depend upon buffering capacity of effluent and Bluegill Pond water and cannot be determined with a simplified dilution calculation. However, the anticipated pH of the effluent is within the regulatory limits.
c - LDEQ, 1994

The dilution factor for nonradiological pollutants was assumed to be equal to the total outflow from Bluegill Pond (including the effluent discharges from the facility) divided by the total volume of discharged effluent:

$$(836{,}000\ m^3)/(389{,}500\ m^3) = 2.1$$

The expected concentrations of each constituent in Bluegill Pond were computed using the expected maximum discharge limits for constituents listed in the NPDES permit divided by the dilution factor of 2.1. However, even without computing the dilution in Bluegill Pond, the concentrations of nonradiological pollutants in the water of Bluegill Pond for all the constituents listed in the NPDES permits are below applicable water quality criteria for the protection of the warm water species habitat and the drinking water standards of the State of Louisiana. Therefore, the discharge of nonradiological constituents is not expected to significantly impact surface water quality and the habitat into which the facility discharges its treated effluent.

There will be two 37,800-liter (10,000-gallon) aboveground storage tanks for backup diesel generator fuel. To minimize the potential for spills during refueling or leaks from these tanks, a secondary steel containment shell will be constructed to encapsulate each tank (LES, 1992d). Any spills or leaks will, therefore, be confined to the secondary shell and will not migrate to surface water or groundwater (LES, 1992h).

The release of airborne contaminants through the facility effluent stacks or by volatilization from spills or open containers may result in the deposition of contaminants on local surface water. The gaseous effluent and surface water monitoring programs (described in Chapter 5) will detect airborne as well as liquid releases.

Assessments of the potential environmental impacts to surface water included an evaluation of flooding potential. The site is located on a topographic high, and no major surface water bodies exist upstream from the site. The nearest surface water confinement will be the Hold-up Basin which will be used during construction to prevent erosion and during operation to prevent stormwater runoff surge control for the CEC (LES, 1994a). Therefore, the presence of water in the basin will likely be intermittent. Because the outflow of the basin will be constructed at an elevation that is 6 m (20 ft) lower than the elevation of the CEC facility, it would not be possible for flooding of the Basin to affect the CEC facility. The Hold-up Basin will have a surface area of approximately 1.2 hectares or 12,150 m^2 (3 acres) and a storage capacity of 46,854 m^3 (38-acre feet). Flood hazard boundary maps were developed by the Federal Emergency Management Agency (FEMA) as part of the National Flood Insurance Program. These maps were evaluated to determine if the facility is located in or near a floodplain and, therefore, if it is subject to flood hazard. FEMA developed flood hazard boundary maps for all of Claiborne Parish, except for those areas designated as "areas of minimal flood hazard." The proposed CEC facility is located in one of the areas designated as an area of minimal flood hazard, and no flood hazard boundary maps were developed for this area. The nearest mapped flood hazard area is located

approximately 5.2 km (3.2 mi) southeast of the southern boundary of the proposed facility, along the shore of Lake Claiborne. Therefore, based on flood hazard information developed by FEMA, the proposed facility is not located in or near a flood hazard area. The Standard Project Flood (SPF) and Probable Maximum Flood (PMF) calculated by LES indicates that the site is not subject to floods from adjacent surface water bodies (LES, 1993a). Any flooding that would occur at the site would be a result of local intense precipitation. The maximum water depth that would accumulate from such an event is 6 cm (2.5 inches). The Separations Building will be constructed 15 cm (6 inches) above the level of the facility yard, 9 cm (3.5 inches) above the expected maximum water level during intense local precipitation.

The same facility operation activities that may impact surface water quality discussed above, may impact groundwater through the infiltration of contaminated surface water. The potential impacts of facility operation on groundwater quality include:

- accidental contaminant releases from fuel storage tanks; and
- infiltration of contaminated water to groundwater.

Accidental releases to groundwater from fuel storage tanks are minimized through the use of steel secondary containment shells. It is possible that groundwater contamination could occur through infiltration from surface water, particularly during periods of low flow. It is more likely that the sediments would contain the contaminants. Contaminants to the groundwater are minimized through compliance with the discharge permits that limit the quantity of contaminants in the liquid effluent. Any contaminant that might reach the groundwater would be further diluted. Additionally, the shallow groundwater under the CEC may not be hydraulically connected to the shallow groundwater outside of the facility boundaries. Groundwater discharges to various streams during much of the year. Therefore, the staff does not expect any adverse impact on the groundwater quality. Monitoring will be performed to confirm this.

4.2.1.2 Land Use

The regrowth of the botanical community surrounding the CEC will continue with the development of common timber species forming a complete forested system. The CEC operation will cause no negative impact to the land use of the immediate surrounding area beyond those that occur during construction.

4.2.1.3 Biotic Resources

Biological diversity and ecological health should improve in the non-plant acreage of the CEC site. This area should mirror the surrounding countryside very well in a number of years, as the site recovers from the deforestation. Erosion should diminish, which would improve stream and pond water quality. Transitional areas such as this are also the most

robust and dynamic systems in a forest and provide food for all types of creatures. The area immediately around the facility will consist mostly of mown grass and some shrubs and trees. This is a very limited environment for plants and animals, but it is a small percentage of the total property area and there is a very large amount of similar land and National forest nearby. Consequently, the net effect is that the land used will not be missed as it is not a critical habitat. The building of additional homes and businesses in the parish will have a more dramatic effect on the availability of space for flora and fauna. The size of the lots and the proximity of the homes may have an impact on migration patterns and may isolate some terrestrial populations. Increased traffic may result in increased road kills, but this increase is expected to be inconsequential when compared to natural die-off.

4.2.1.4 Noise

Noise from operation of the plant will be primarily generated by trucks and heavy equipment moving cylinders and by traffic moving to and from the facility. The noise at the nearest residence will be due almost entirely to the increased traffic levels. The noise will be greater than existing conditions but not noticeably so. The primary difference is that the noise level will be more continuous during the day, with levels during the night equivalent to daytime periods during shift changes.

In general, noise in the parish should not be increased significantly except along roads around the plant at the time of nighttime shift changes. While the noise should not cause hearing damage or be any louder than in the daytime, the noise levels at some residences would be high enough to cause some disturbance of sleep. This would bother most people for relatively short periods of time as they adjust to the noise.

Electric motors and well-balanced centrifuges that are shock/vibration-mounted should not generate excessive noise outside of a well-designed building. Noticeable noise from these sources at offsite locations is considered highly unlikely.

4.2.1.5 Traffic

Approximately 180 people will be employed as operations staff at the facility. Assuming that this is the daily employment level, that about 10 to 20 trucks arrive per day (vendors, supplies, and cylinder trucks), and that some people go out to lunch, the traffic count would be around 33 percent of the number of cars anticipated during the peak construction phase (about 545 vehicles per day). This is a 25 percent increase over existing maximum traffic counts on the road segments of Parish Road 39 leading to the site. This additional volume of traffic can easily be handled by the road and connecting roads assuming that they can avoid Homer's Courthouse Square area to some extent. Also, these increases in traffic load would be limited to shift change periods. During operation, increased traffic is expected to increase vehicle related injuries by about 2.33 injuries and 0.06 fatalities per year.

In general, traffic in the parish would be expected to increase slightly along all roads leading to the plant site; thus, road maintenance costs would also increase, particularly along roads traveled by heavy equipment and trucks carrying cylinders of uranium hexafluoride.

4.2.1.6 Air Pollution

The major sources of nonradiological emissions will be indirect sources, such as emissions from vehicles coming to the site and from the electrical generation plants supplying power. These emissions are relatively minor in nature and will not cause an exceedance of the NAAQS. Continued use of dust suppression measures will be maintained until parking lots are paved and exposed soil is successfully revegetated. Emissions of solvents from various activities should be minor and must comply with Louisiana air pollution regulations, which require covers on all open sources of emissions when not in use (e.g., degreasers and open cans of solvents or paint).

CEC operation will routinely release small quantities of hydrogen fluoride (HF) in dilute, gaseous form, and degreaser from the elevated Separations Building stack. HF is a strong dehydrating agent and can, in concentrated form, char wood and paper on contact. Anhydrous HF and higher concentrations of hydrofluoric acid are very corrosive to skin, eyes, lungs, and mucous membranes. Dilute solutions of HF may induce deep-seated skin ulceration at some time following exposure (Drury et al., 1980). In cases of inhalation of concentrated HF, the respiratory inflammation and pulmonary edema overshadow the general aspects of fluoride poisoning. Also, HF can be absorbed through the skin in enough quantity to induce fluoride poisoning. The annual average HF release rate from CEC is estimated to be 6.45 kg/yr or about 0.7 g/hr. Combining this release estimate with the maximum χ/Q (approximately 800 m north of the plant stacks) yields an estimate of 1.1×10^{-7}mg HF/m^3. Regulatory limits for HF in the atmosphere have not been established. The estimate, however, is a factor of 30 million less than the American Conference of Government Industrial Hygienists (ACGIH) time-weighted average (TWA) threshold limit value of 2.5 mg/m^3 for occupational exposure to HF (ACGIH, 1986).

Exposure of vegetation to HF can result in fluoride accumulation and external injury to leaf margins and tips, which often have higher fluoride concentrations than the rest of the leaf blade. The effects of HF will depend on the stage of development of the vegetation, the concentration of the acid in the air, the length of the exposure, and the climatic factors. Excess exposures can cause growth inhibition, necrosis of foliage, chlorosis, wilting, and eventual death of the plant. Continuous exposure to HF is more harmful to vegetation than intermittent exposure (Drury et al. 1980). Most injured plants would probably recover from short-term and intermittent exposures (NRC, 1986b). Exposure to concentrations of airborne fluoride below 8 mg/m^3 for 1 hour is not generally sufficient to produce injuries to vegetation (NRC, 1986b). Therefore, the potential impact of small HF releases and the short period of exposure on surrounding vegetation is expected to be negligible. Similarly, since the potential HF releases during operation of CEC are very small and intermittent in nature, no injury to domestic animals or wildlife is expected.

The emission of chlorofluorocarbons (CFCs) from the facility would constitute an air pollutant that would not have an adverse health effect on the community, but would make a small contribution to the damage to the stratospheric ozone layer. Destruction of the ozone layer would contribute to increases in ailments and effects on the environment due to increased amounts of ultraviolet light. The annual release rate for Freon R-113 from the Separations Building is conservatively estimated to be 8,640 kg (19,000 lbs). This release rate is conservative and unlikely to occur. It assumes complete inventory release and no recovery of the Freon R-113. This conservative release rate will yield approximately $1.5x10^{-4}$ mg/m^3, for an average annual ambient concentration of Freon R-113 at the point of maximum concentration, approximately 800m north of the plant stacks. This value is considerably less than the TWA threshold limit of 7,600 mg/m^3 for occupational exposures established by ACGIH (1986). While the ambient concentrations are minimal and short-term, the CFCs potential releases would contribute to the long-term effect on the destruction of the ozone layer.

The Centrifuge Assembly Building (CAB) is equipped with a general HVAC system with no effluent filtration or monitoring. Operations conducted in the CAB will not involve radioactive materials, but will use and release acetone and Freon R-113. Acetone and Freon R-113 releases during assembly, inspection, and mechanical testing of centrifuges are estimated to be 100 and 400 kg/yr, respectively. These releases yield ambient annual average air concentration estimates of $1x10^{-3}$ mg/m^3 for acetone and $4x10^{-3}$ mg/m^3 for Freon R-113 at the point of maximum concentration, approximately 800m north of the plant stacks. These potential releases of acetone and freon would not be through the plant stacks. These two values are small compared to the ACGIH TWA threshold limits (ACGIH, 1986). The TWA threshold limit for acetone is 1,780 mg/m^3. Accordingly, Freon R-113 combined releases from the Separations Buildup and CAB are expected not to exceed $4.1x10^{-3}$ mg/m^3.

Based on this assessment, the potential impacts associated with the release of all nonradiological gases during the normal operations of the CEC are negligible in terms of acute or chronic health effects to exposed individuals or to the environment. The long-term effect of the release of the Freon R-113 to the environment will be as a potential contributor to the overall long-term impact on the stratospheric ozone of global CFC releases. Reduction of the ozone layer will result in increases in ultraviolet-B radiation, which may damage sensitive plants and contribute to an increase in melanomae in humans.

LES, however, has identified potential substitutes for Freon R-11 and Freon R-113. (LES, 1994b). Currently, HFC-134a is the likely substitute for R-11. It contains no chlorine and has been recommended for short-term replacement of R-11 by the EPA. It has a very low toxicity.

Because the actual substitute for freons has not been chosen, the discussion here assumes that Freon R-113 is used. The impact from the potential substitute is expected to be less than from freon. LES has stated that a substitute will be used at CEC.

Potential substitutes for Freon R-113 are Axarel® 6000 and 9000 series cleaning agents. These cleaning chemicals are biodegradable and not toxic to aquatic life. They are not listed RCRA hazardous waste and have low vapor pressures that limit volatile organic compound emissions. Axarel® 6000 and 9000 are made up of mixed aliphatic hydrocarbons. Generally, precautions are required in handling these solvents because prolonged epidermal contact may cause irritation and swelling. Other adverse reactions may include nervous system depression with anaesthetic feeling. These reactions are unlikely, however, with proper ventilation and worker protection programs. Environmental impacts associated with these substitutes are expected to be less than those predicted for the CFCs.

4.2.1.7 Socioeconomic and Community Support Services

The following sections describe the social, economic, and community impacts of CEC operations. The towns of Homer and Haynesville have been emphasized due to their proximity to the proposed facility location and their status as providers of community services.

4.2.1.7.1 Public Services

- General Education -- No negative impact on the local primary and secondary educational facilities is expected. Claiborne Parish currently has a student/teacher ratio of 15.7:1, which is better than the State average of 17.1:1. Moreover, the school system has twice the physical capacity necessary to provide for the current student population of 3,127, a figure higher than any increase from an influx of families associated directly or indirectly with CEC.

- Public Safety -- Along with a general increase in economic activity, there may be some increased demand for expanded business hours and all-night businesses. This would tend to increase the potential for crime at such businesses, as would any similar increase in economic activity. CEC plans no night workers during construction, except security, and only 10 night-shift operations workers.

  Claiborne Parish is currently coping with criminal activity arising from cocaine and crack. It is believed that most criminal activity occurring relates to drug dealing or other drug-related crimes (e.g., burglaries and thefts). Section 3.6.2.2 summarizes current crime rates. The sheriff of Claiborne Parish believes that the parish has its share of problems, but is not facing a high-crime problem (Oakes, 1993). The Parish's rising crime rate is believed to have been in step with population growth during the last 2 decades (Cicarelli, 1994). Some believe that police resources are strained at present (Featherston, 1992), or that the fluctuating nature of past criminal activity is an indication that there are times of strain (Pueh, 1994).

  Based on these conditions, local law enforcement resources are unlikely to be sufficient to accommodate the increase in demand stemming from CEC construction and

operation. Local authorities would need to expand the police force to avoid a deterioration in local public safety service. An estimated two to four more police officers would need to be added to the local forces at Homer and Haynesville beyond already projected hiring levels. Such an expansion would have effects on the local government budget, which may or may not be offset by increased tax revenues arising from the CEC facility or associated personnel settling within the Parish. This public safety and budgetary impact may be the most notable negative social impact of the facility.

- Health Services -- The Homer Memorial Hospital has 64 beds and the ability to handle a 30-35 percent increase in patient load without any problems. Since CEC is projected to have its own first-aid resources, and personnel will commute from beyond the parish area, local health services are not expected to be strained or to sustain a negative impact due to CEC construction and operations.

- Housing -- For the last 2 years there has been an oversupply of lower quality and older homes on the market. However, there are very few homes, apartments, or mobile homes available for rent. Construction and operation of CEC would be expected to bid up rental prices and, to a lesser extent, home purchase prices; and will probably stimulate new construction. Any shift of this nature is expected to be minimal since there is an oversupply of homes for sale and people can choose residences over a wide area.

- Recreational Facilities -- Lake Claiborne, Lake Claiborne State Park, Kisatchie National Forest, Carney Lake, and the Donogue State Park together receive such a large number of annual visitors (48,200 in fiscal year 1988-89 for Lake Claiborne State Park alone), that any increase due to CEC personnel would be insignificant and unlikely to have a measurable impact.

4.2.1.7.2 Demography

- Population -- The projected peak total employment of 545 in Year 4 (400 construction and 145 operations personnel) for the CEC facility could have a detectable impact on total population in the parish area. The effect depends on the concentration of migrating construction and operations workers, dependents, and secondary economic migrants within Claiborne Parish. LES estimates that about 85 percent of the workers will live within commuting distance and approximately 12 percent will move into the Parish from other areas of Louisiana. Over the long-run, the operations workforce is projected to be 180 people. The impact of these operations workers and associated dependents and secondary economic migrants on Claiborne Parish will be small.

- Employment -- Operations jobs are likely to be filled by existing residents of the 24-parish labor pool, particularly at the lower-end of the skill and pay scale. At the higher-end, a greater proportion of migrants will take the jobs. At the very upper-end

(e.g., health physicists, chemical engineers, etc.), individuals will mostly be brought in from existing high-technology chemical and nuclear facilities in other parts of the U.S. In this respect, it is worth noting that the migration rate for high-technology workers is not only high but higher than that for the rest of the work force (Herzog et al., 1986). This migration rate is a function of the mobility of high-technology workers in the U.S., not CEC *per se*. Thus, a significant amount of migration for the high-technology jobs can be expected.

On the other hand, LES plans to employ people in accordance with the Louisiana Enterprise Zone Act. This requires that LES certify that at least 35 percent of its employees:

(a) are residents of the same parish as the location of the business,

(b) receive some form of public assistance prior to employment,

(c) be considered unemployable by traditional standards or lack basic skills, or

(d) be subject to any of the above.

Adherence to this Act will substantially improve the job opportunities of existing local residents.

Within the labor pool, there are undoubtedly numerous individuals with the basic skills and experience for the lower and middle-range jobs at the facility. The labor pool is, however, highly stratified. Of the adult (age 16 and over) population in the narrowly defined seven-county LES employment region (as defined by LES, 1994a), more than 30 percent are not high school graduates. In Claiborne Parish, non-high school graduates represent almost 47 percent of the population ages 16 and older. In both cases, the rates are disproportionately higher for blacks than whites. Most of the employed individuals of both races work in lower skill, lower wage jobs. The likelihood of job training and operations employment will be concentrated among a group of currently more qualified and more educated individuals. These individuals are statistically more likely to be white than black. Lesser qualified individuals in the area will obtain jobs in the cafeteria, administration, general plant maintenance, and support services areas. Through experience, training, and initiative, employees at the lower end of the pay scale will have the opportunity to advance and earn higher wages.

- Economic Conditions -- The relative absence of industrial operations and manufacturing workers in the parish and nearby parishes is because LES specifically chose to locate in an area with no heavy industrial or manufacturing employers (see Section 2.7). While this site selection criterion is an advantage in areas like land cost, labor cost, and

public acceptance (to get the high paying jobs), it is a disadvantage in getting a skilled work force from the nearby population.

4.2.1.7.3 Quality of Life

Impacts on the quality of life in Claiborne Parish and nearby communities during and after construction of CEC will depend on certain factors relating to the influx of new residents during construction and operations. The influx of new residents may temporarily strain established social and community bonds. Such strains are not unusual and are part of the normal process of adjustment to an influx of people to a rural area.

The boomtown effect is generally used to describe the consequence of rapid increases in population (at least 5-10 percent per year) in small (populations of thousands to a few tens of thousands) rural (30-50 miles or more from a major city) communities undergoing rapid increases in economic activity. By these standards, Claiborne Parish would be below the boomtown threshold because most immigrants are expected to reside throughout the area, not just Claiborne Parish.

4.2.1.7.4 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898 directing Federal agencies to develop a strategy for assuring environmental justice in their programs, policies, and activities. Environmental justice refers to identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of programs, policies, and activities on minority and low-income populations. Procedures for implementing the Order are still being developed.

The NRC staff has considered the issue of environmental justice from two perspectives:

1. Is there evidence that LES selected the proposed CEC site based on racial considerations?

2. Will minority and economically disadvantaged populations be disproportionately affected by the CEC?

The proposed CEC site is located between two predominantly African-American communities, Center Springs and Forest Grove. Almost 50 percent of Claiborne Parish residents are minorities. Many commentors on the DEIS alleged that LES deliberately chose the site because it was in an African-Ameriycan community. However, the commentors did not cite any specific evidence to support their allegation, but rather relied essentially on the end-result to support the allegation. The NRC staff has carefully reviewed public comments and the LES description of the site selection process. The LES process appears to be based solely on business and technical considerations. The staff found no specific evidence that racial considerations were a factor. LES did consider such factors

as land cost and financial incentives offered by governments to attract industry; however, these items would be considered by any company and are not evidence of environmental injustice.

The NRC staff also considered whether minorities will be disproportionately adversely impacted by operation of the CEC. The staff recognizes that to the extent the CEC affects the environment, those living closest will be the most affected. All aspects of CEC operation will be required to comply with State and Federal environmental regulations. The staff has not identified any significant offsite adverse impacts that would occur as a result of CEC construction and operation. The minority communities of Forest Grove and Center Springs would be inconvenienced by the Parish Road relocation, increasing the driving time between the communities. The distance between the Forest Grove Church and the Center Springs Church is approximately 1.8 km (1.1 miles); the relocation of the road will add approximately 600 meters (0.38 mile) to the distance. Relocation of residents will not occur as a result of facility or road construction.

All effluent releases from the CEC would be below established limits and doses are expected to be well within the regulatory limits. No significant impacts to the health of local residents or the environment are expected as a result of the CEC. The NRC staff has concluded that the impacts associated with the CEC will be relatively small, and that there will not be a disproportionate adverse impact on minority or low-income populations. Furthermore, the CEC will bring substantial employment and economic benefits which will ybenefit the entire population.

In summary, the staff concludes that the proposed LES facility is not an example of environmental injustice. That is, the staff found no evidence of racial considerations being used in the site selection process, and the staff does not believe that facility operation will result in significantly disproportionate adverse impact.

4.2.1.8 Cultural, Historic, and Archaeological Resources

- Cultural – No negative impacts are expected from the construction and operation of the CEC facility on the cultural resources of the parish.

- Historic – There are no sites of historic significance within the CEC buffer or facility areas (as defined by the United States National Register of Historic Places). No negative impact on the existing nine historic sites within Claiborne Parish should arise due to the construction, operation, or influx of workers from the CEC facility.

- Archaeological – A recent study by Survey Unlimited Research Associates concluded that the CEC site has no historic or prehistoric value. The only major finding, a projectile point dated from 2,000 BC to 500 AD, is most likely an isolated item, and in the absence of any evidence of occupation (i.e., camp site or tool-making area) indicates that construction and operation of the CEC facility would have no measurable

archaeological impact. This conclusion is shared by the Division of Archeology, Office of Cultural Development, of the Department of Culture, Recreation and Tourism of the State of Louisiana. It is important to stress though, that any new findings as a result of construction or operations must be immediately reported to the latter office.

4.2.1.9 Transportation

The principal nonradiological risks associated with transportation are personal injury and property loss suffered in vehicular accidents associated with the shipment of UF_6. Using national accident rates, the potential national impacts due to UF_6 feed and product shipments are less than one injury (0.5 injuries/yr) and no (0.03 deaths/yr) fatalities per year. Using local Claiborne Parish accident rates, the potential impacts in Claiborne Parish are no (0.01 injuries/yr) injuries and no (0.0003 deaths/yr) fatalities per year.

4.2.2 Radiological Impacts

Public exposure to uranium may occur from routine operations as a result of small, controlled releases to the atmosphere from the uranium enrichment process lines and decontamination and maintenance of equipment, releases of radioactive liquids to surface water, and as a result of direct exposure from storage and transportation of UF_6 cylinders. Direct radiation and skyshine (radiation reflected from the atmosphere) in offsite areas due to operations within the Separations Building are expected to be undetectable since most of the direct radiation associated with the uranium will almost completely be absorbed by the heavy process lines, walls, equipment, and tanks to be employed at CEC.

The consequence of internal and external radiation exposure, deposition of energy in body tissues, is represented as absorbed dose. Absorbed dose is quantified as energy absorbed per unit tissue mass. The biological effect on individual tissues is estimated by multiplication of absorbed dose by a factor which accounts for the relative biological effect of differing types of radiation. This modified tissue dose is called dose equivalent. The effect on the whole body is represented as a risk-weighted sum of the set of tissue dose equivalents. This dose, called the effective dose equivalent (EDE), is integrated over a period of years to account for the accumulated effect from a single year's exposure. This time-integrated measure of effect is called the committed effective dose equivalent (CEDE). CEDEs representing internal exposures are combined with dose estimates for external exposure to calculate a measure of effect for both exposure modes. The combined dose is called the total effective dose equivalent (TEDE).

The new NRC 10 CFR Part 20 provides an explicit TEDE limit for the public of 1.0 mSv/yr (0.1 rem/yr) from all sources, and includes both internal and external doses through all pathways (including food). External dose rates cannot exceed 0.02 mSv (2 mrem) in any 1 hour. Further, LES would be subject to EPA's generally applicable standards in EPA 40 CFR Parts 61 and 190. Part 190 requires that routine releases from uranium fuel cycle facilities to the general environment not result in annual doses exceeding 0.25 mSv

(25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ. Part 61 requires that routine releases to the atmosphere not result in an annual effective dose equivalent exceeding 0.1 mSv (10 mrem).

As the facility design is currently proposed, the major source of public exposure would be expected to be from atmospheric releases. Such releases would be primarily controlled through the Separations Building ventilation system. All air to be released from potentially contaminated areas of the facility would be filtered by prefilters and high efficiency particulate filters (HEPAs) to remove most of any particulate radioactivity prior to discharge.

The operational monitoring program would also be a major part of the radiological compliance program, since it would indicate whether the process and effluent control systems were operating properly. Environmental measurements would also permit estimates of potential radiological impacts on local residents in the event detectable radioactivity from normal operations or accidents was to be found. The results of the environmental monitoring program will be submitted biennially for NRC review. Additionally, LES will inform the staff of significant changes in dose parameters.

The balance of this section presents a discussion of potential individual and collective population doses resulting from routine operation of the CEC, a comparison of these doses to applicable standards, a discussion of impacts of potential accidents, and a summary of the methods used to develop this assessment. The major assumptions used in the analysis are described in the discussion of dose evaluation and accident evaluation methods in Section 4.2.2.1.

4.2.2.1 Dose Evaluation Methods

Radioactive material released to the atmosphere, surface water, and groundwater is dispersed during transport through the environment and transferred to human receptors through inhalation, ingestion, and direct exposure pathways. Therefore, evaluation of impacts requires consideration of potential receptors, source terms, environmental transport, exposure pathways, and conversion of estimates of intake to dose. LES presented in its Environmental Report (LES, 1994a) an assessment of the potential radiological impacts associated with its CEC operation. This section presents a summary of the independent approach used by NRC to evaluate radiological impacts of CEC operations.

Estimates used in this assessment of the atmospheric and liquid releases of uranium are developed based on review of operation of similar existing plants and on engineering evaluation of equipment function. The annual releases to the atmosphere and surface waters from the CEC are estimated to be less than $4.4\times10^{+6}$ Bq (120 μCi) and $1.0\times10^{+6}$ Bq (28 μCi), respectively.

The radiological impact assessment in this EIS includes consideration of the population surrounding the proposed CEC out to a distance of 80 kilometers (50 miles) and of a set of individuals whose exposure would bound all foreseeable impacts related to CEC operation. The primary component of atmospheric dispersion is mechanical mixing produced by temperature and wind velocity gradients. For projected normal operational releases the methods of Regulatory Guide 1.111 (NRC, 1977c) are used to estimate concentrations of released material at a range of distances and directions from the release point. These methods use the Gaussian plume dispersion model and are implemented in the XOQDOQ computer code (Sagendorf, et al., 1988). Concentrations per unit release quantity (i.e., χ/Q) predicted using this model and appropriate meteorological data are summarized in Table 4.13. The atmospheric dispersion modeling predicted that the maximum annual average air concentration of releases ($\chi/Q = 5.5x10^{-7}$ s/m^3) would occur approximately 800 meters north of the plant stacks.

The total population considered, 349,000, and the distribution by area are presented in Table 3.39. The four individuals whose exposures would bound potential impacts were assumed to be located 800 meters (2,625 ft) north of the plant stacks at a permanent residence, 570 meters (1,870 ft) south-southeast of the plant stacks at the edge of Bluegill Pond, 1,235 meters (4,050 ft) south-southeast of the plant stacks at a permanent residence, and 6,500 meters (4 miles) south of the plant stacks at the northern edge of Lake Claiborne. The atmospheric dispersion modeling results presented in Table 4.13 indicate that the maximum annual average air concentrations would occur approximately 800 meters north of the plant stacks. Therefore, the individual assumed to be located 800 meters north of the plant stacks is the maximally exposed individual for the air pathway. The 800 meter north, 1,235 meter south-southeast, and Lake Claiborne residents (6,500 m southeast) represent individuals expected to live at or near these locations. The Bluegill Pond resident (570 m south-southeast) is a hypothetical individual selected to establish the upper bound of potential impacts of normal operational releases from the liquid pathway. The residence located at 1,235 meters (4,050 ft) south-southeast is at the point of potential maximum exposure for direct and skyshine radiation.

The primary component of dispersion during surface water transport is dilution due to mixing of stream and river flows. A simple material balance model using CEC site-specific surface water hydrology data (LES, 1993a) is used to estimate the degree of dilution and related concentrations of released material throughout the environment.

While there are no direct discharges to the groundwater, radionuclides deposited onto soils and sediment could be leached into groundwater. Using a conservative estimate of annual atmospheric release rate [$4.4x10^{+6}$ Bq (120 μCi)], the maximum annual average χ/Q (Table 4.13), and a deposition velocity of 0.001 m/s, total deposition for a 30-year period is estimated to be $7.4x10^{-6}$ mBq/cm^2 ($2.0x10^{-4}$ pCi/cm^2). If this quantity of uranium were dispersed through the upper centimeter of soil, the average uranium concentration would be $3.7x10^{-6}$ mBq/g ($1.0x10^{-4}$ pCi/g). This is a small fraction of normally occurring uranium concentrations in soil. Similarly, if all of the uranium contained in a 30-year volume of CEC

Table 4.13 Annual Average Dispersion Analysis (χ/Q) for the CEC (s/m^3)

Direction	Distance (m)									
	402	805	2414	4023	7241	12068	24135	40225	56315	72405
S	$3.142x10^{-07}$	$3.428x10^{-07}$	$1.392x10^{-07}$	$8.177x10^{-08}$	$4.365x10^{-08}$	$2.509x10^{-08}$	$1.157x10^{-08}$	$6.507x10^{-09}$	$4.437x10^{-09}$	$3.330x10^{-09}$
SSW	$1.377x10^{-07}$	$1.685x10^{-07}$	$7.659x10^{-08}$	$4.641x10^{-08}$	$2.539x10^{-08}$	$1.480x10^{-08}$	$6.912x10^{-09}$	$3.903x10^{-09}$	$2.667x10^{-09}$	$2.004x10^{-09}$
SW	$1.550x10^{-07}$	$1.579x10^{-07}$	$6.488x10^{-08}$	$3.941x10^{-08}$	$2.183x10^{-08}$	$1.287x10^{-08}$	$6.085x10^{-09}$	$3.467x10^{-09}$	$2.381x10^{-09}$	$1.795x10^{-09}$
WSW	$1.313x10^{-07}$	$1.505x10^{-07}$	$6.569x10^{-08}$	$3.941x10^{-08}$	$2.128x10^{-08}$	$1.227x10^{-08}$	$5.652x10^{-09}$	$3.167x10^{-09}$	$2.154x10^{-09}$	$1.614x10^{-09}$
W	$2.206x10^{-07}$	$2.279x10^{-07}$	$1.074x10^{-07}$	$6.977x10^{-08}$	$4.044x10^{-08}$	$2.432x10^{-08}$	$1.164x10^{-08}$	$6.656x10^{-09}$	$4.573x10^{-09}$	$3.448x10^{-09}$
WNW	$1.922x10^{-07}$	$2.078x10^{-07}$	$1.131x10^{-07}$	$8.429x10^{-08}$	$5.733x10^{-08}$	$3.851x10^{-08}$	$2.062x10^{-08}$	$1.250x10^{-08}$	$8.868x10^{-09}$	$6.828x10^{-09}$
NW	$2.670x10^{-07}$	$3.184x10^{-07}$	$1.879x10^{-07}$	$1.421x10^{-07}$	$9.594x10^{-08}$	$6.352x10^{-08}$	$3.340x10^{-08}$	$2.003x10^{-08}$	$1.413x10^{-08}$	$1.084x10^{-08}$
NNW	$2.463x10^{-07}$	$3.077x10^{-07}$	$1.620x10^{-07}$	$1.164x10^{-07}$	$7.811x10^{-08}$	$5.243x10^{-08}$	$2.819x10^{-08}$	$1.716x10^{-08}$	$1.221x10^{-08}$	$9.417x10^{-09}$
N	$4.754x10^{-07}$	$5.466x10^{-07}$	$2.553x10^{-07}$	$1.652x10^{-07}$	$9.828x10^{-08}$	$6.102x10^{-08}$	$3.052x10^{-08}$	$1.792x10^{-08}$	$1.251x10^{-08}$	$9.534x10^{-09}$
NNB	$1.991x10^{-07}$	$1.904x10^{-07}$	$8.614x10^{-08}$	$5.768x10^{-08}$	$3.600x10^{-08}$	$2.320x10^{-08}$	$1.205x10^{-08}$	$7.227x10^{-09}$	$5.103x10^{-09}$	$3.918x10^{-09}$
NB	$2.212x10^{-07}$	$1.878x10^{-07}$	$7.587x10^{-08}$	$5.000x10^{-08}$	$3.101x10^{-08}$	$1.996x10^{-08}$	$1.035x10^{-08}$	$6.206x10^{-09}$	$4.380x10^{-09}$	$3.363x10^{-09}$
ENB	$2.208x10^{-07}$	$1.755x10^{-07}$	$9.174x10^{-08}$	$7.759x10^{-08}$	$5.979x10^{-08}$	$4.322x10^{-08}$	$2.466x10^{-08}$	$1.543x10^{-08}$	$1.112x10^{-08}$	$8.654x10^{-09}$
B	$1.965x10^{-07}$	$1.593x10^{-07}$	$8.837x10^{-08}$	$7.999x10^{-08}$	$6.607x10^{-08}$	$4.969x10^{-08}$	$2.931x10^{-08}$	$1.860x10^{-08}$	$1.351x10^{-08}$	$1.056x10^{-08}$
ESB	$1.265x10^{-07}$	$1.307x10^{-07}$	$6.298x10^{-08}$	$4.489x10^{-08}$	$3.040x10^{-08}$	$2.070x10^{-08}$	$1.131x10^{-08}$	$6.948x10^{-09}$	$4.967x10^{-09}$	$3.845x10^{-09}$
SB	$1.759x10^{-07}$	$1.836x10^{-07}$	$7.362x10^{-08}$	$4.254x10^{-08}$	$2.213x10^{-08}$	$1.248x10^{-08}$	$5.639x10^{-09}$	$3.135x10^{-09}$	$2.125x10^{-09}$	$1.588x10^{-09}$
SSB	$1.451x10^{-07}$	$1.537x10^{-07}$	$5.542x10^{-08}$	$3.049x10^{-08}$	$1.551x10^{-08}$	$8.783x10^{-09}$	$4.041x10^{-09}$	$2.286x10^{-09}$	$1.566x10^{-09}$	$1.180x10^{-09}$

liquid effluent were to accumulate in a 1-centimeter layer of Bluegill Pond sediment, uranium concentration would be $1.5x10^{-2}$ Bq/g (0.4 pCi/g). Given the conservative assumptions and the low solubility of uranium in water, this is an insignificant concentration. Thus, significant concentrations of uranium in groundwater are not expected to occur as a consequence of normal operations of the CEC.

Members of the public may be exposed to radioactive material dispersed in the environment through inhalation of air, ingestion of drinking water, ingestion of terrestrial foods and animal products, inadvertent ingestion of soil, and direct irradiation from nuclides deposited on the ground or present in surface water. Guidance on acceptable exposure models for these pathways has been published in NRC Regulatory Guide 1.109 (NRC, 1977b) and incorporated into a variety of computer codes. The GENII code (Napier, et al., 1988), which implements versions of the NRC recommended models, was used to estimate doses in this EIS. To the extent possible, modeling parameters, such as age specific inhalation and food consumption rates, were those recommended in Regulatory Guide 1.109 (NRC, 1977b). For the purposes of these evaluations, individuals were assumed to derive their entire terrestrial and animal product food consumption from locally-grown crops. A potential component of offsite radiological impact is direct and skyshine radiation from UF_6 cylinders stored at the CEC. At the CEC, site buildings and the surrounding vegetation will block a portion of the direct radiation and the low angle component which comprises the majority of skyshine. The impact of direct and skyshine radiation from stored cylinders on the surrounding population is expected to be small and is considered in this analysis.

Radionuclide uptake rates estimated with the environmental transport and exposure pathway models were converted to dose equivalent using metabolic and physical distribution and energy deposition models. For the evaluations of this EIS, the dose conversion approach and models recommended in ICRP-26 (ICRP, 1977) and -30 (ICRP, 1979) were used. Doses estimated using the GENII pathway code were adjusted using the dose conversion factors (DCF) for adults published in NUREG/CR-0150 (NRC, 1981b). Doses estimated for the adult age category were converted to dose estimates for the teen, child, and infant age categories using the relative age-specific dose factors published in NUREG/CR-4628 (NRC, 1986a). Tissue specific dose conversion factors used for comparison with the EPA's 40 CFR Part 190 criteria were those published in NUREG/CR-0150. The DCFs provide an estimate of the committed effective dose equivalent (CEDE) that would be incurred over a 50-year period due to 1 year's exposure via internal intake. In all cases, the released nuclides were assumed to be a soluble form of the uranium-234 isotope as recommended in ICRP-26 for UF_6 and related compounds. Since the released particles would be formed from vapor phase condensation and would be filtered through HEPA filters, the average particle size at the point of release would be small. In order to provide a conservative impact analysis, the particle diameter in the gaseous effluents was assumed to be 0.3 microns.

4.2.2.2 Dose Estimates for Atmospheric Releases

Radioactive material would be released to the atmosphere from the proposed CEC through a stack at an elevation of 36.6 meters (120 ft). The source term used for the calculations is $4.4 \times 10^{+6}$ Bq (120 μCi) per year of uranium isotopes. Expected exposure pathways include inhalation of air and direct exposure from material deposited on the ground. In addition to these expected routes of exposure, members of the public may also consume food containing deposited radionuclides and inadvertently ingest soil resuspended from the ground or food (e.g., leafy vegetables, carrots, and potatoes) containing low levels of uranium. Potential tissue dose equivalents and effective dose equivalents for the maximally exposed adult individuals and the population are presented in Table 4.14.

The distribution of these doses through the various food pathways for an adult at the 800 meter-north residence is presented in Table 4.15. The estimates indicate that the inhalation and food ingestion pathways each contribute approximately half of the total dose. Dose contributions from the ground deposition and plume external exposures are approximately one-millionth of the total projected dose. TEDEs are thus numerically equal

Table 4.14 Potential Doses to Adult Individuals and the Population from Atmospheric Releases

Tissue	Maximally Exposed Individual Doses (Sv)[a]			Population (Person-Sv)
	Bluegill Pond	Lake Claiborne	800 Meter Resident	
Gonads	8.8×10^{-12}	2.8×10^{-12}	3.0×10^{-11}	1.1×10^{-7}
Breast	5.6×10^{-12}	1.8×10^{-12}	2.0×10^{-11}	7.0×10^{-8}
Red Bone Marrow	2.3×10^{-10}	6.8×10^{-11}	7.6×10^{-10}	2.7×10^{-6}
Lung	8.4×10^{-11}	2.6×10^{-11}	2.8×10^{-10}	1.2×10^{-6}
Thyroid	8.8×10^{-12}	2.8×10^{-12}	3.0×10^{-11}	1.1×10^{-7}
Bone Surface	3.5×10^{-9}	1.0×10^{-9}	1.2×10^{-8}	4.2×10^{-5}
Stomach	1.0×10^{-12}	3.2×10^{-13}	3.5×10^{-12}	1.2×10^{-8}
Small Intestine	1.4×10^{-12}	4.4×10^{-13}	4.8×10^{-12}	1.5×10^{-8}
Upper Large Intestine	4.8×10^{-12}	1.4×10^{-12}	1.6×10^{-11}	4.4×10^{-8}
Lower Large Intestine	1.6×10^{-11}	4.8×10^{-12}	5.2×10^{-11}	1.4×10^{-7}
Kidney	1.7×10^{-9}	5.2×10^{-10}	5.6×10^{-9}	2.0×10^{-5}
CEDE	2.5×10^{-10}	7.6×10^{-11}	8.0×10^{-10}	3.0×10^{-6}

[a] 1 Sievert (Sv) = 100 rem

Table 4.15 Potential Doses to the 800-meter Resident Adult for Major Pathways from Atmospheric Releases

Tissue	Maximally Exposed Adult Doses (Sv)[a]			
	Inhalation	Terrestrial Food Ingestion	Animal Product Ingestion	Inadvertent Soil Ingestion
Gonads	$1.8x10^{-11}$	$1.1x10^{-11}$	$8.8x10^{-13}$	$3.8x10^{-15}$
Breast	$1.2x10^{-11}$	$7.2x10^{-12}$	$5.6x10^{-13}$	$2.4x10^{-15}$
Red Bone Marrow	$4.4x10^{-10}$	$2.9x10^{-10}$	$2.4x10^{-11}$	$1.0x10^{-13}$
Lung	$2.8x10^{-10}$	$6.0x10^{-12}$	$4.8x10^{-13}$	$2.1x10^{-15}$
Thyroid	$1.8x10^{-11}$	$1.1x10^{-11}$	$8.8x10^{-13}$	$3.8x10^{-15}$
Bone Surface	$6.8x10^{-9}$	$4.4x10^{-9}$	$4.0x10^{-10}$	$1.5x10^{-12}$
Stomach	$1.7x10^{-12}$	$1.7x10^{-12}$	$1.4x10^{-13}$	$5.6x10^{-16}$
Small Intestine	$1.7x10^{-12}$	$2.8x10^{-12}$	$2.4x10^{-13}$	$9.6x10^{-16}$
Upper Large Intestine	$2.0x10^{-12}$	$1.3x10^{-11}$	$1.1x10^{-12}$	$4.4x10^{-15}$
Lower Large Intestine	$2.6x10^{-12}$	$4.4x10^{-11}$	$3.9x10^{-12}$	$1.5x10^{-14}$
Kidney	$3.3x10^{-9}$	$2.2x10^{-9}$	$1.8x10^{-10}$	$7.2x10^{-13}$
CEDE	$4.8x10^{-10}$	$3.0x10^{-10}$	$2.6x10^{-11}$	$1.0x10^{-13}$

[a] 1 Sievert (Sv) = 100 rem

to CEDEs. Potential doses estimated for maximally exposed individuals in the teen, child, and infant age categories are somewhat higher than the adult doses presented in Table 4.14. An infant located at the 800 meter residence would be the critical individual for the air pathway and could receive a CEDE of $2.4x10^{-9}$ Sv ($2.4x10^{-7}$ rem). The largest tissue dose would be $5.4x10^{-8}$ Sv ($5.4x10^{-6}$ rem) to the bone surface of the infant. For both maximally exposed individuals and members of the population, the estimated doses are a small fraction of applicable standards and the 1 mSv (0.1 rem) dose (excluding 2 mSv from indoor radon) that the individual would receive from natural background sources each year.

4.2.2.3 Dose Estimates for Liquid Releases

Radioactive material would be released from the proposed CEC to surface water in Bluegill Pond as a consequence of normal operations. The low levels of radionuclides would travel with the water from the pond west to Cypress Creek and southward through Lake Claiborne toward the Gulf of Mexico. The source term is conservatively estimated to be $1.0x10^{+6}$ Bq (28 μCi) per year of uranium isotopes. Potential exposure pathways include drinking water ingestion, terrestrial and animal product food ingestion, aquatic product ingestion, and direct exposure during recreational activities (e.g., swimming, fishing, and boating). The analysis

assumes that water containing low levels of uranium is used to irrigate crops grown for human and animal consumption. The estimates of population dose are based upon the assumption that the entire population surrounding the site out to a distance of 50 miles uses water containing levels of uranium estimated for Cypress Creek, the first publicly available source of water off the CEC site. These assumptions provide a very conservative estimate of potential liquid pathway exposures. Potential tissue dose equivalents and CEDEs for the maximally exposed adult individuals and the population are presented in Table 4.16. The resident assumed to be located 800 meters north of the plant stacks will not likely have access to potentially contaminated water and is therefore not included in the liquid pathway dose evaluation.

The distribution of these potential doses through the food pathways for the potential adult resident at Lake Claiborne is presented in Table 4.17. The drinking water, terrestrial food, fish, and animal product ingestion pathways contribute approximately 20, 35, 35, and 10 percent, respectively, of the CEDE. Potential doses from the recreational direct exposure pathways would be approximately one-millionth of the total estimated CEDEs. TEDEs are thus numerically equal to the CEDEs.

Table 4.16 Potential Doses to Adult Individuals and the Population from Liquid Releases

Tissue	Maximally Exposed Individual Doses (Sv)[a]		Population (person-Sv)
	Bluegill Pond	Lake Claiborne	
Gonads	$2.5x10^{-8}$	$1.0x10^{-8}$	$1.7x10^{-3}$
Breast	$1.6x10^{-8}$	$6.6x10^{-9}$	$1.1x10^{-3}$
Red Bone Marrow	$6.1x10^{-7}$	$2.6x10^{-7}$	$4.3x10^{-2}$
Lung	$2.8x10^{-8}$	$1.1x10^{-8}$	$1.9x10^{-3}$
Thyroid	$2.5x10^{-8}$	$1.0x10^{-8}$	$1.7x10^{-3}$
Bone Surface	$9.5x10^{-6}$	$4.0x10^{-6}$	$6.9x10^{-1}$
Stomach	$1.1x10^{-8}$	$4.4x10^{-9}$	$7.6x10^{-4}$
Small Intestine	$2.4x10^{-8}$	$1.0x10^{-8}$	$1.7x10^{-3}$
Upper Large Intestine	$1.5x10^{-7}$	$6.2x10^{-8}$	$1.1x10^{-2}$
Lower Large Intestine	$4.5x10^{-7}$	$1.8x10^{-7}$	$3.1x10^{-2}$
Kidney	$4.5x10^{-6}$	$1.9x10^{-6}$	$3.2x10^{-1}$
CEDE	$6.8x10^{-7}$	$2.8x10^{-7}$	$4.9x10^{-2}$

[a] 1 Sievert (Sv) = 100 rem

Table 4.17 Potential Doses to Lake Claiborne Adult Resident for Major Pathways from Liquid Releases

Tissue	Maximally Exposed Adult Doses (Sv)[a]			
	Drinking Water Ingestion	Terrestrial Food Ingestion	Aquatic Product Ingestion	Animal Product Ingestion
Gonads	2.1×10^{-9}	3.6×10^{-9}	4.3×10^{-9}	5.1×10^{-10}
Breast	1.3×10^{-9}	2.3×10^{-9}	2.7×10^{-9}	3.2×10^{-10}
Red Bone Marrow	5.0×10^{-8}	8.5×10^{-8}	1.3×10^{-7}	1.3×10^{-8}
Lung	2.2×10^{-9}	4.0×10^{-9}	4.7×10^{-9}	5.5×10^{-10}
Thyroid	2.1×10^{-9}	3.6×10^{-9}	4.3×10^{-9}	5.1×10^{-10}
Bone Surface	7.9×10^{-7}	1.4×10^{-6}	1.6×10^{-6}	1.9×10^{-7}
Stomach	8.8×10^{-10}	1.5×10^{-9}	1.8×10^{-9}	2.2×10^{-10}
Small Intestine	2.0×10^{-9}	3.5×10^{-9}	4.1×10^{-9}	4.9×10^{-10}
Upper Large Intestine	1.2×10^{-8}	2.0×10^{-8}	2.5×10^{-8}	3.1×10^{-9}
Lower Large Intestine	3.7×10^{-8}	6.3×10^{-8}	7.6×10^{-8}	9.1×10^{-9}
Kidney	3.5×10^{-7}	6.4×10^{-7}	7.7×10^{-7}	9.3×10^{-8}
CEDE	5.6×10^{-8}	9.7×10^{-8}	1.2×10^{-7}	1.4×10^{-8}

[a] 1 Sievert (Sv) = 100 rem

Potential doses estimated for the maximally exposed individuals in the teen, child, and infant age categories range from 2 to 10 times the doses presented in Table 4.16. The critical individual would be a hypothetical infant located at Bluegill Pond. The potential CEDE estimated for this infant would be 6.0×10^{-6} Sv (6.0×10^{-4} rem), and the largest tissue dose would be 1.4×10^{-4} Sv (1.4×10^{-2} rem) for the bone surface. This estimate is based on the assumption that the infant drinks milk produced by cows whose entire liquid intake comes from Bluegill Pond water. The estimates are therefore highly conservative. For both maximally exposed individuals and members of the population, the estimated doses are a small fraction of applicable standards and the 1 mSv (100 mrem) dose that an individual would receive from background radiation sources.

4.2.2.4 Dose Estimates for Direct and Skyshine Radiation

Cylinders containing UF_6 stored at the CEC are a potential source of direct and skyshine radiation to residents located near the CEC. Surface dose rates from a single cylinder of UF_6 are estimated to be less than 2×10^{-5} Sv/hr (2 mrem/hr) (Friend, 1991). Using this estimate of dose rate, the maximum annual dose to the 1,235 south-southeast resident from direct radiation is estimated to be 6.0×10^{-7} Sv (6.0×10^{-2} mrem). The maximum annual dose

due to skyshine is estimated to be 2.6×10^{-5} Sv (2.6 mrem). The estimates are based upon storage of the maximum number of cylinders allowed by the proposed license conditions (that is, approximately 4,560 cylinders) and are therefore conservative. The critical organ for this mode of exposure is the thyroid for which the annual dose is 2.9×10^{-5} Sv (2.9 mrem). The combined effect of direct and skyshine dose from all cylinders is a small fraction of background radiation and applicable standards.

4.2.2.5 Evaluation of Cumulative Radiological Impact for Routine Operations

NRC regulations (10 CFR 20.1301) require that the TEDE for members of the public for routine operations not exceed 1 mSv (100 mrem) per year. In addition, EPA regulations (40 CFR Part 190) require that for routine releases to the general environment, the annual dose equivalent not exceed 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ. For releases to the atmosphere, EPA regulations (40 CFR Part 61) require that the annual effective dose equivalent not exceed 0.1 mSv (10 mrem). The maximum potential cumulative annual impact to any individual for potential CEC atmospheric and liquid releases is estimated to be a CEDE of *6.0 μSv (0.6 mrem) to an infant located at Bluegill Pond. The maximum organ dose* was estimated to be 37 μSv (3.7 mrem) to the whole bone. The whole bone dose represents the affect on the entire bone tissue, including both the bone surface and the red bone marrow. These dose estimates assume that the infant's milk is produced by milk cows whose entire liquid intake comes from Bluegill Pond water. For all pathways (atmospheric, liquid, and direct), the critical individual is an adult located at the 1,235 meter south-southeast residence. The annual TEDE is estimated as 2.6×10^{-2} mSv (2.6 mrem) and the maximum annual tissue dose is estimated as 2.9×10^{-2} mSv (2.9 mrem) to the thyroid. Based on the conservative assumptions used in the analysis, the maximum doses will be within limits set by the NRC and EPA. Actual doses are expected to be lower than the conservative estimates of this analysis.

4.2.2.6 Transportation

The NRC, in a prior environmental impact statement, has evaluated the impacts of the transport of radioactive materials (NRC, 1977a). This analysis concluded that: "The average radiation dose to the population at risk from normal transportation is a small fraction of the limits recommended for members of the general public from all sources of radiation other than natural and medical sources and is a small fraction of natural background dose." This conclusion has been verified for the case of the CEC using dose rates measured for full cylinders and conservative modeling assumptions. The analysis assumed a surface dose rate of 0.02 mSv/hr (2 mrem/hr) for a full cylinder and considered an individual exposed at a distance of 15 meters for 1 minute for each feed, product, and tails cylinder entering and leaving the CEC. The 0.002 mSv/yr (0.2 mrem/yr) dose rate estimated for these conditions would be a small fraction of the dose received from natural background radiation or the increased dose from a short commercial airline flight. Exposures to workers associated with transportation of all feed, product, and tails cylinders

were estimated as 3.0×10^{-4} person-Sv/yr (3.0×10^{-2} person-rem/yr). The dose to an average member of the crew is a small fraction of the 10 CFR Part 20 limit for occupational exposure.

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4.2.2.8 Radiological Impacts of DUF_6 Conversion and U_3O_8 Disposal

Depleted uranium tails will be shipped offsite for conversion and disposal. Conversion of DUF_6 to U_3O_8 will result in releases of radioactive material to air and water. In addition to U_3O_8, large quantities of calcium fluoride (CaF_2), containing low uranium concentrations, will also be generated. Disposal of U_3O_8 could result in slow releases of uranium and uranium decay products to the groundwater infiltrating the disposal facility. Members of the public could come into contact with the groundwater due to natural flow and mixing or through intrusive activities. This section summarizes the analytical methods used and the estimates of potential impacts of conversion of DUF_6 to U_3O_8 and disposal of the U_3O_8. Detailed descriptions of the analysis and results are presented in Appendix A.

<u>Impacts of Conversion from DUF_6 to U_3O_8</u>

Because there are no facilities in the U.S. which convert DUF_6 to U_3O_8, the staff has assumed a representative conversion site and plant. Normal operation of the DUF_6 conversion process may result in small releases of uranium to the atmosphere and surface water. The magnitudes of these impacts were evaluated using the dose estimation procedures described in Section 4.2.2.1. Atmospheric release dose pathways include inhalation of air and ingestion of crops. Liquid release dose pathways include ingestion of drinking water and crops. Receptors considered were a maximally exposed individual living near the plant and the population surrounding the plant out to a distance of 80 km (50 miles). For a generic conversion plant, the maximally exposed individual was assumed to be located at a residence 0.5 km (.31 mile) from the plant's exhaust stacks, and the population surrounding the plant was assumed to include approximately 400,000 people.

Release rates of uranium to the atmosphere and surface water were estimated as $3.0 \times 10^{+7}$ Bq/yr (8.0×10^{-4} Ci/yr) and $1.9 \times 10^{+8}$ Bq/yr (5.2×10^{-3} Ci/yr), respectively. Potential dose to the maximally exposed adult due to atmospheric releases was estimated as 7.0×10^{-9} Sv/yr (7.0×10^{-4} mrem/yr). Collective dose was estimated as 3.2×10^{-5} person-Sv/yr (3.2×10^{-3} person-rem/yr). The critical individual for the atmospheric pathway is an infant located at the nearest residence. The estimated CEDE for the infant is 8.8×10^{-8} Sv/yr (8.8×10^{-3} mrem/yr) and the largest tissue dose is 5.4×10^{-7} Sv/yr (5.4×10^{-2} mrem/yr) to the bone.

The potential dose to the maximally exposed adult as a result of releases to surface water was estimated as 3.4×10^{-8} Sv/yr (3.4×10^{-3} mrem/yr). Collective dose was estimated to be 1.0×10^{-3} person-Sv/yr (1.0×10^{-1} person-rem/yr). The critical individual for the liquid pathway is an infant located at the nearest residence. The estimated CEDE for the infant due to liquid releases was estimated as 2.9×10^{-7} Sv/yr (2.9×10^{-2} mrem/yr) and the largest tissue dose was 1.8×10^{-6} Sv/yr (0.18 mrem/yr) to the bone. For both the atmospheric and liquid

releases, external exposures are a factor of a million less than the internal exposures. In addition to the atmospheric and liquid pathway exposures, an individual may be subject to direct and skyshine radiation from cylinders stored at the conversion site. Direct and skyshine doses (EDEs) imparted to the maximally exposed individual were estimated as $1.8x10^{-7}$ Sv/yr ($1.8x10^{-2}$ mrem/yr) and $2.6x10^{-5}$ Sv/yr (2.6 mrem/yr), respectively. The critical organ for the direct/skyshine pathway is the thyroid with an annual dose of $2.9x10^{-5}$ Sv/yr (2.9 mrem/yr). All estimated doses are small fractions of applicable limits and of the dose received from background radiation.

Impacts of Disposal of U_3O_8

There are currently no disposal facilities for large quantities of DUF_6, but it is plausible to assume that U_3O_8 may be disposed by emplacement in near-surface or deep geologic disposal units. The quantity of uranium to be disposed is the 30-year CEC tails inventory or $9.1x10^{+7}$ kg ($2.0x10^{+8}$ lb) expressed as U_3O_8 (equivalent to a volume of $3.0x10^{+4}$ m^3 [$1.1x10^{+6}$ ft^3]). A near-surface disposal unit is assumed to be an earth-mounded bunker (tumulus) with a U_3O_8 matrix measuring approximately 61 m (200 ft) long by 61 m (200 ft) wide and 8 m (26 ft) high. A deep geological disposal unit is assumed to be a pre-existing cavity such as an abandoned mine, with a U_3O_8 matrix measuring approximately 100 m (320 ft) long by 100 m (320 ft) wide and 3 m (9.8 ft) high. The radiological dose limits specified in 10 CFR Part 61 are adopted as a basis for comparative evaluation. Under this regulation, annual dose to any member of the public is limited to $2.5x10^{-4}$ Sv (25 mrem) to the whole body, $7.5x10^{-4}$ Sv (75 mrem) to the thyroid, and $2.5x10^{-5}$ Sv (25 mrem) to any other organ.

The tails disposal impact analysis method included selection of assumed generic disposal sites, development of undisturbed performance and deep well water use exposure scenarios, and estimation of potential doses. Exposure pathways used for the near-surface disposal case include drinking shallow well water and consuming crops irrigated with shallow well water. Evaluation of the deep disposal case included undisturbed performance and deep well water exposure scenarios. In the undisturbed performance scenario, groundwater flows into a river which serves as a source of drinking water and fish. For the well water use exposure scenario, an individual drills a well into an aquifer downgradient from the disposal facility and uses groundwater for drinking and irrigation.

The release of uranium isotopes and their daughter nuclides from the disposal facility is limited by their solubility in water. Solubilities were estimated using the PHREEQE computer code (Parkhurst et al., 1980) developed at the U.S. Geological Survey (USGS). Maximum inventories of nuclides present in a U_3O_8 matrix were estimated using computerized evaluation of the Bateman equation (Benedict et al., 1981). Concentrations of radionuclides in groundwater and corresponding doses were estimated using a combination of an analytic solution to the one-dimensional flow, three-dimensional dispersion, transport equation developed by the USGS (Wexler, 1992) and the unit soil contamination dose factors developed with the RESRAD computer code (Gilbert et al., 1989). The RESRAD factors incorporate the effects of inadvertent soil ingestion and

ingestion of crops, meat, and milk. The dose estimates were corroborated using the PRESTO-EPA (Fields et al., 1987) code to recalculate the near-surface scenario impacts.

Using the environmental characteristics of a humid southeastern U.S. site and the methods of this EIS, drinking water and agricultural doses were estimated to be $5.7x10^{-3}$ Sv/yr (570 mrem/yr) and $3.1x10^{-4}$ Sv/yr (31 mrem/yr), respectively, for a near surface disposal facility. These doses exceed 10 CFR Part 61 limits, making it likely that a deep disposal site will be selected.

In order to compensate for the lack of knowledge of a specific deep disposal site, two representative sites whose geological structures have previously been characterized were selected for analysis. Site 1 (Rechard, 1993) is located in a granite formation overlain by a thin layer of glacial till. Emplacement of the U_3O_8 matrix at Site 1 is assumed to be at a depth of approximately 290 m (950 ft). Site 2 (Stottlemyre et al., 1979) is located in a sequence of interbedded sandstone and basalt layers. Emplacement of the matrix at Site 2 is assumed to be at a depth of 635 m (2,070 ft). At each of the sites, vertical fractures intersect the emplacement horizon, allowing water to be carried upward to an aquifer and then to a river. The fracture sizes, hydraulic conductivities, and hydraulic gradients used in the EIS analysis are the same as those used in the referenced studies (Rechard, 1993 and Stottlemyre et al., 1979).

Potential consequences of emplacement of U_3O_8 in a geological disposal unit include intake of radionuclides from drinking water, irrigated crops, and fish. Under the assumed conditions for the undisturbed performance scenario, groundwater would be discharged to a river. Under conditions not expected to occur, an individual would obtain groundwater by drilling a well downgradient from the disposal unit. The well take-off point was located at the center elevation of the aquifer. The horizontal location of the well was the distance of maximum dose (200 meters) for a take-off point at the selected elevation.

The analysis considers nuclides present in the emplaced U_3O_8 and nuclides produced by decay during transport. By evaluating solubility-limited releases, the upper bound of potential dose was estimated. In the year of maximum exposure at the granite site (Site 1), the estimated doses for the well scenario were $1.6x10^{-7}$ Sv ($1.6x10^{-2}$ mrem) and $2.3x10^{-6}$ Sv (0.23 mrem) for drinking water and agriculture pathways, respectively. For the river scenario at the granite site (Site 1), expected doses were estimated to be $5.3x10^{-16}$ Sv ($5.3x10^{-11}$ mrem) and $1.0x10^{-15}$ Sv ($1.0x10^{-10}$ mrem) for drinking water and fish ingestion pathways, respectively. In the year of maximum exposure at the sandstone/basalt site (Site 2), expected doses for the well scenario were estimated to be $1.3x10^{-10}$ Sv ($1.3x10^{-5}$ mrem) and $1.8x10^{-9}$ Sv ($1.8x10^{-4}$ mrem) for drinking water and agriculture pathways, respectively. For the river scenario at the basalt site, expected doses were estimated to be $1.6x10^{-9}$ Sv ($1.6x10^{-14}$ mrem) and $3.0x10^{-14}$ Sv ($3.0x10^{-9}$ mrem) for drinking water and fish ingestion pathways, respectively.

All estimated impacts for a deep disposal facility are less than the 0.25 mSv/yr (25 mrem/yr) level adopted from 10 CFR Part 61 as a basis for comparison. For the well

scenario, the estimated dose is dominated by ^{226}Ra originating at the disposal facility and its relatively short-lived daughter radionuclides which develop during transport. For the river scenario, almost all of the ^{226}Ra originating at the disposal facility decays during transport and the estimated dose was dominated by the less soluble ^{238}U parent nuclide and its daughter radionuclides developing during transport. The assumptions used in the analysis, including neglect of potential engineered barriers, mass transfer limitations in releases, and decay and retardation during vertical transfer contribute to a conservative analysis.

If for some reason a deep geological facility is not selected for tails disposal, the tails can be stored indefinitely in a retrievable surface facility with minimal environmental impacts. The environmental impacts associated with such storage would be commitment of the land for a storage area, and a small offsite radiation dose.

4.2.3 Cumulative Environmental Impacts

The cumulative environmental impacts as a result of facility operation include:

- drawdown of the Sparta Sand Aquifer due to water withdrawals for plant operation;
- possible reduction in shallow groundwater levels beneath the site;
- reduction in water levels in Lake Avalyn;
- possible accumulation of contaminants in surface water sediments;
- possible bioaccumulation of contaminants in surface water biota;
- reduction in ozone content of stratosphere.

Drawdown is expected in the Sparta Sand Aquifer due to water use at the site. Depending on the scenario considered, drawdown due to site activities ranges from 0.03 to 1.2 m (0.1 to 4 ft) at the facility boundary. The drawdown at the site is small and ranges from 10 to 12 percent of the total drawdown at the nearest public water supply well, Claiborne Well No. 4. Normal facility operations are expected to pump water at the lower rates considered, so that the effect of site water usage on the total aquifer is expected to be minimal (LES, 1993a).

A potential decrease in the levels of shallow groundwater also exists at the site due to construction activities. Approximately 28 hectares (70 acres) of the site will be developed and largely paved during facility construction (LES, 1994a). Water which would have infiltrated over this area will become part of the site drainage through the Yard Drains System and, therefore, be unavailable for shallow groundwater recharge. The developed

portion of the site is only 16 percent of the total site area. The effect would occur directly beneath the site and would unlikely extend offsite.

Local surface waters are likely to be most strongly affected by site construction and operation activities. LES estimates that 20 percent of the surface water drainage to Lake Avalyn will be rerouted from facility yard drains to Bluegill Pond. A reduction in the water level in Lake Avalyn is therefore expected. In the summer months in particular, the water flow in both Drainage Basins is reduced, so that some recession of the Lake Avalyn shoreline is likely (LES, 1994a). The effects of this reduction in surface water recharge may become more significant during the operating life of the facility.

LES will monitor surface water effluents to measure releases and to assure that necessary measures will be taken to meet established NPDES limits (LES, 1994a and 1993d) and NRC regulatory standards. Releases of contaminants to site surface waters will, therefore, be minimized. However, some releases of both radioactive and nonradioactive contaminants are expected due to site activities. The potential exists for these contaminants to accumulate in the sediments of the surrounding surface water bodies. Accumulation of uranium in the upper one-centimeter layer of Bluegill Pond sediment for a 30-year operational period is expected to be less than 37 mBq/g (1 pCi/g). The long-term environmental effects that result include the possibility that these sediments will act as a secondary source of surface water contamination and possibly groundwater contamination.

Bioaccumulation of contaminants released to surface waters is also possible. The uranium from the facility does not pose a potential bioaccumulation hazard, since it does not tend to accumulate in animal tissue. However, other potential contaminants, in particular, lab solvents and analytical reagents which might be released (LES, 1992h), may constitute a bioaccumulation hazard.

Releases of CFCs, HCFCs, perchloroethylene, and carbonlehachloride will contribute to the long-term depletion of the earth's ozone layer.

4.2.4 Adverse Environmental Impacts that Cannot be Avoided

Certain environmental impacts due to CEC site construction and operation cannot be avoided. These include:

- clearing of vegetation for facility construction, utility lines, and relocation of Parish Road 39
- erosion and sedimentation of surface water and reduction in water levels in Lake Avalyn
- drawdown of the Sparta Sand Aquifer
- contaminant releases

To construct the facility buildings, storage yards, and parking lots, existing vegetation (brush and forest) must be cleared. The construction of the two utility lines from the Haynesville and Bernice substations will require clearing of about 144 hectares (355 acres) of wooded land. The two strips of land will be intermittently cut low for maintenance of the lines. In addition, approximately 5.7 hectares (14 acres) of timberland will be cleared for the relocation of Parish Road 39.

Despite mitigative measures, construction and operation activities are still likely to result in increased erosion and sedimentation of surface water. This increase is likely to impact the biota in the surrounding surface water bodies, including Bluegill Pond, Lake Avalyn, and the small streams which drain the site. The impact on these biota will depend upon the effectiveness of erosion control measures. The reduction in water levels in Lake Avalyn would lead to potential increases in total dissolved solids and a reduction of surface area of the Lake. These changes, however, are not expected to have a serious impact on aquatic life because of the high tolerance of existing aquatic species to environmental changes in temperature and TSS.

LES analyzed the drawdown in the potentiometric surface of the Sparta Sand Aquifer as a result of pumping of groundwater from facility water supply wells. The results of the analysis indicate that the facility wells will cause a drawdown of up to 1 m (3 ft) at the southern property boundary (LES, 1994a). However, this amount of drawdown is localized and small and is expected to be insignificant with respect to the estimated regional drawdown of 3 to 9 m (10 to 30 ft) caused by large regional water supply pumping centers in the Sparta Sand Aquifer in northern Louisiana.

Accidental and routine releases of radiologic and nonradiologic contaminants may result in adverse local environmental impacts. Design, controls, and administrative procedures will be utilized to minimize the possibility of accidental releases, and contingency plans are being developed to respond to accidental releases (LES, 1993a and 1992h). The chemicals that may be released as a result of accidents are uranium, hydrogen fluoride, freon, fluorotrichloromethane, trichlorofluoroethane, methanol, acetone, perchloroethylene, and laboratory chemicals. LES determined that acute inhalation exposure presents the most serious hazard in the event of an accidental release (LES, 1993a). Modelling results indicate that potential offsite impacts of contaminant releases are minimal (LES, 1993a). NRC staff agrees that potential releases of chemicals would have an inconsequential effect on offsite populations.

4.2.5 Relationship Between Short-Term Uses and Long-Term Productivity

The affected environment includes the LES 178 hectares (442 acres) site and surrounding areas. The short-term uses of the area include the CEC plant, the buffer zone, Bluegill Pond, Avalyn Lake, sparse residential communities, and recreational areas. The proposed action will use only 28 hectares (70 acres) of the site for the plant. The gaseous and liquid effluents to the natural environment will be continuously monitored and controlled. The

site will be decommissioned to an unrestricted use condition at the end of plant life. These insignificant potential impacts will not lead to any long-term degradation of air, water, and land or present a danger to human health.

A positive effect of the end of the decommissioning phase of the proposed action is the enhancement of the botanical environment and wildlife habitat at the site.

4.2.6 Irreversible and Irretrievable Commitment of Resources

This section discusses the irreversible and irretrievable commitment of land, water (hydrology), biotic, building materials, fuel, and chemical resources as a result of the operation of the CEC facility.

4.2.6.1 Land

The land area owned by LES is 178 hectares (442 acres), the majority of which will remain as open or forested land. About 28 hectares (70 acres) of the property will be used for the plant site and about 6 hectares (14 acres) will be used for the rerouting of Parish Road 39. *An additional 144 hectares (355 acres) will be used for constructing utility lines.* At the end of plant operation, the plant site is required to be decontaminated and decommissioned so that the property can be used for unrestricted purposes. The plant site is likely to remain as an industrial site, and the road is considered permanent.

Due to the nature of the material received, its handling, and the storage method, there is very limited potential for significant volumes of soil to become radioactively contaminated and to require disposal. Estimated uranium deposition for a 30-year period would be $7.4x10^{-6}$ mBq/cm^2 ($2x10^{-4}$ pCi/cm^2). If this quantity of uranium were dispersed through the upper centimeter of soil, the average uranium concentration would be $3.7x10^{-6}$ Bq/g ($1x10^{-4}$ pCi/g). This is a small fraction of normal background concentration in soil.

Sediments that are generated in the two ponds during the operational and decommissioning phases may be slightly contaminated with radionuclides. This is a volume that is difficult to estimate since most of the sediment generated will occur during the construction phase and the early operational phase before vegetation can limit erosion. It can be assumed that about two to three feet of sediment will accumulate in the two ponds. However, if all the uranium contained in a 30-year volume of liquid effluent were to accumulate in a 1-cm layer of sediment, the uranium concentration would be $1.5x10^{-2}$ Bq/g (0.4 pCi/g).

Part of the landfill volume in the Parish will be irretrievably lost due to the presence of the facility. Additional landfill volume loss will be due to the people coming into the area to work at the facility or to take advantage of opportunities for business in the area caused by the plant and the influx of people into a rural setting.

4.2.6.2 Hydrology

The extraction of groundwater for plant use from the Sparta Sand Aquifer is neither irreversible nor irretrievable. Water will naturally recharge the aquifer. However, artesian pressure equivalent to the one prior to use will probably not occur, since current anticipated demands on the aquifer already forecast a large loss of pressure. This represents then no loss of water resources, but indicates that increased pumping energy will be required to obtain them. Groundwater contamination is potentially possible due to the anticipated presence of contaminants in the ponds but is not expected. Groundwater monitoring is designed to measure the extent of contamination so that only a limited volume is contaminated prior to detection. This groundwater would be considered lost although treatment could remove the contamination.

There will be no irreversible or irretrievable loss of surface water, but due to the recontouring of the site there is a diversion of water to different watersheds. This diversion amounts to a loss or gain in the volume of runoff in the watershed. As the volume is very small, the amount involved is not expected to result in a noticeable increase in flooding or a worsening or mitigation of drought conditions. Some limited effects on fish, flora and fauna may occur in the area of these upper reaches as available territories or ranges would be influenced by the amount of water present and the speed of runoff.

4.2.6.3 Biotic Resources

Twenty eight-hectares (70 acres) of the site, plus additional areas for the rerouted Parish Road 39 and utility rights-of-way, will be eliminated as suitable habitat for animals and plants. The road is essentially just moving locations and does not result in a substantial change to the environment. Increased traffic on roads will result in increased traffic deaths of animals, but should not affect the population of any species adversely. The remaining land at the site will support more species with more diversity than the previous use allowed. The two utility strips will be continuously maintained and cut low for easy access and line maintenance. A loss of habitat associated with the building of new homes and businesses to accommodate the new workers and associated retail/commercial development will represent a long-term loss of habitat.

4.2.6.4 Building Materials

The construction of the buildings at the site represents an irreversible loss of materials. Construction and demolition debris will likely be landfilled, while foundations and structural material will probably remain in use for the life of the building prior to being landfilled. Items in this category include cement, aggregate, reinforcing and structural steel, lumber, piping materials, electric wires, insulation, and roofing materials.

Some materials associated with the processing of the uranium will have become contaminated and will require disposal in a licensed LLW disposal commercial facility.

4.2.6.5 Fuel and Chemicals

During the construction, operation, and decommissioning of the facility, fuel will be used to operate trucks and vehicles, and to produce electricity for the operations. The facility will also be irretrievably consuming oxygen, acetylene, freon, and other chemicals. The amount of fuel and chemicals used by this proposed action is substantially less than achieving the same uranium beneficiation using conventional gaseous diffusion methods. Uranium tails (depleted uranium) represent what is essentially a waste material that currently has very limited usefulness and whose supply greatly exceeds the limited demand. This material and the steel cylinders in which it is stored will eventually be disposed of and will represent an irretrievable and irreplaceable loss. Actual losses of chemicals will be small in comparison with other similar-sized industrial facilities. The electrical use will be large and represent relatively the largest use of resources. During normal operation, the facility is expected to use 18 MW. The amount of electrical energy required to produce one SWU is 50 kilowatt hours. The total amount of fuels and chemicals used will depend on the total volume of material processed during the life of the plant. Water usage during operation will range between 20 to 30 liters per minute (5 to 7 gallons per minute), all of which will effectively be discharged after treatment to Bluegill Pond.

The loss of Freon R-113, used as a degreaser, represents a permanent loss of a valuable chemical. While the chemical will not be manufactured after 1995, its use would contribute to the depletion of available supplies.

It is recognized that fuel usage may be much greater if more individuals employed by LES decide to commute from larger towns such as Shreveport or El Dorado.

4.2.7 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Plans and Policies

At this time, the NRC staff is not aware of any conflict between the proposed action and the objectives of Federal, Regional, State, or local plans, policies, or controls for the action proposed as long as proper agencies are contacted, proper applications are submitted and proper monitoring and mitigatory measures are taken to protect the environment and public health and safety.

4.3 Decontamination and Decommissioning

The primary environmental impacts of the decontamination and decommissioning (D&D) of the CEC include alteration of releases to the atmosphere and surrounding waters and disposal of industrial trash and decontaminated equipment. The steps and activities undertaken in D&D of the CEC are described in Section 2.3.5 of this EIS. This section summarizes the potential environmental impacts of D&D of the site through comparison with normal operational impacts.

D&D activities are organized into three steps which are expected to require approximately 7 years. The first major step, requiring about 1 1/2 years, includes the characterization of the site, the development and obtaining NRC approval of the decommissioning plan, and installation of D&D equipment within the existing facilities. The D&D equipment is comprised of a specialized system to dismantle and decontaminate centrifuges and a flexible system for D&D of the remaining plant components. The second major step, requiring about 4 years, involves process system purging, dismantling of equipment, D&D of equipment and facilities, and disposal of waste. Equipment which will be removed includes all UF_6 containment systems, direct support systems, and radioactive and hazardous waste handling systems. Site infrastructure, such as electrical power and water supply, heating, ventilation, and air conditioning (HVAC) systems, and sewage treatment, will remain in place. The third major step, requiring approximately 1 year, includes execution of the final radiation survey. Following completion of these steps, the site will be released for unrestricted use. An NRC confirmatory survey will likely be conducted before site release to ensure compliance with regulatory commitments and limits.

During the first step (Year 1) of the D&D period, electrical and water use will decrease dramatically as enrichment activities are terminated and preparations for D&D are implemented. Environmental impacts of this phase are expected to be small as normal operational releases have stopped. During the second major step of the D&D process, water use will increase and aluminum and low-level radioactive waste will be produced. Contaminated D&D solutions will be treated in a liquid waste disposal system before release to the environment. The treatment system would be similar to that used during operations. Concentrations of uranium in the effluent will be less than 5 percent of the 10 CFR Part 20 limit for releases to unrestricted areas. CEC plans to sell approximately 4500 metric tons of aluminum from centrifuge casings and 250 metric tons of aluminum from piping. CEC expects the resale aluminum to contain between 2 and 4 ppm of uranium. The aluminum will have to meet the release criteria in place at the time of decommissioning. Radioactive waste produced annually in the D&D process is comprised primarily of crushed centrifuge rotors, trash, and citric cake. The total volume of low-level radioactive waste generated during the D&D period is estimated to be 100 m^3 (3,530 ft^3). This waste will be disposed in a licensed low-level waste disposal facility. Releases to the atmosphere are expected to be minimal compared to the small normal operational releases. The final major step in the D&D process, the radiation surveys, does not involve adverse environmental impacts.

In summary, the adverse environmental impacts of D&D of the CEC are expected to be small and on the order of normal operational impacts. The mitigating environmental impacts include release of the facilities and land for unrestricted use, termination of releases to the environment, discontinuation of a large portion of water and electrical power consumption, and reduction in vehicular traffic. The economic cost of D&D borne by the applicant is estimated to be approximately 33 million dollars (exclusive of costs for tails disposition).

Decommissioning impacts will be localized in the immediate CEC developed site. No disposal of waste, including radioactive waste, is expected to take place at the site. Waste production during decommissioning will include crushed centrifuge rotors, normal trash, and citric cake containing uranium. The estimated annual radioactive waste volumes produced during the midst of this phase would be roughly equal to that produced during normal operation (LES, 1993d and 1992d). Radioactive wastes in the initial and final years of decommissioning would be much lower.

4.3.1 Noise

Noise levels during decommissioning will be generated by heavy construction equipment and will include substantial banging due to the movement of large pieces of metal scrap. The noise levels will be similar to those experienced during the construction of the plant. Levels of 110 dB within the fenced area and around 70 dB offsite are expected. The activity is expected to occur during daytime and to last for a few months. Nighttime noise levels will drop to preconstruction levels due to the reduction in nighttime traffic volume.

4.3.2 Air Pollution

During the decontamination phase of the facility, transportation and heavy vehicles will produce exhaust emissions and dust as they move on the road and around the site. The exhaust emissions are small and will not cause any noticeable change in air quality in the area. The emission of dust from the construction/decommissioning equipment and from reentrainment of dust and dirt that is carried or deposited on the road will be the most significant air impact. The amount of dust may be a nuisance problem for local residents and a health problem for workers if no mitigation measures are used, especially during dry spells.

The use of Freon R-113 as a degreaser in the Separations Building will not contribute directly to increased tropospheric air pollution, but will contribute to depletion of the stratospheric ozone layer. This depletion will cause an increase in ultraviolet light hitting the earth. Negative effects on plants, animals, sea level, smog formation, and climate are expected. Although the amount released is a small percentage of the total worldwide release, the chemicals are expected to have an impact for many years while in the stratosphere. The atmospheric half life of CFC-R-113 is estimated to be between 79 and 96 years (Connell, 1989). While LES does not plan to use CFC-R-113, the substitute has not been identified. The staff has assumed the potential impacts from the use of Freon R-113 to be conservative and the potential substitute impacts would be considerably less.

There is the potential for significant emissions of solvents during the decontamination phase if solvent cleaning methods are employed. These emissions would be of short duration (e.g., a few weeks) and would probably involve less than 10 tons of solvent. The revised Clean Air Act (CAA) will have developed control requirements for any toxic solvents and, possibly, developed regulations governing the use of solvents in such applications. Gaseous effluent

volume that resulted during operation will be slightly reduced because the process off-gas inputs to the stack will be shut down.

4.3.3 Traffic

Traffic during decontamination and decommissioning should be less than the amount experienced during either the construction or the operational phase of the plant. The roads should be able to sustain the flow easily. However, it is expected that the number of heavy trucks will be substantial for brief periods of time as different wastes are removed.

4.3.4 Hydrology

Consumption of water is expected to increase during the decommissioning phase, particularly during the middle of the 7-year decommissioning phase. This is associated with actual decontamination performance. Liquid effluents will show an increase during the same period. These effluents will primarily result from the treatment of citric acid solutions that are used to recover uranium and other metals. Spent citric acid solution will be treated to assure that discharges meet the liquid effluent discharge limits.

4.3.5 Socioeconomic

The cost for D&D is projected to be approximately $518 million (1996 dollars). Of this amount, $485 million ($16.2 million per each year of operation) is for the disposition of UF_6 tails. D&D costs for the facility are about $33 million spread over about 7 years. LES uses four percent inflation for future D&D costs. Deflating LES' 1996 dollars to 1990 dollars at four percent produces a total cost of about $409 million (1990 dollars), of which $383 million is for the disposition of UF_6 tails. Use of a 4 percent annual inflation rate to deflate 1996 dollars slightly understates costs expressed in 1990 dollars.

In general, labor requirements for decommissioning are likely to be less than those for plant operations. With an annual average work force of about 25 individuals during most of the decommissioning phase, it is reasonable to assume socioeconomic impacts like those for operations, but at a much lower level, probably no more than 15 percent as large as for plant operations.

At the conclusion of both the operations phase and the D&D phase, the reduction in direct and indirect employment at CEC will impose socioeconomic dislocations in the area if Claiborne Parish or nearby parishes are unable to generate a stable, continuing base of skilled manufacturing jobs or related activities unrelated to CEC's existence. When a large, high-skill, high-wage manufacturer in a small town closes, direct and indirect economic and employment losses are registered and significant outmigration of skilled and younger workers occurs. This effect is not unique to CEC, but it has the potential to be pronounced in and around Claiborne Parish because of the wage rates at CEC and the lack of any comparable manufacturing infrastructure in the area.

4.4 No-Action Alternative

The no-action alternative is the denial of the NRC license necessary to construct and operate the CEC. With this alternative, the impacts, both positive and negative, discussed in this chapter would be eliminated. The site is assumed to revert to its former use, however, the owner would be free to pursue other uses.

Environmentally, the likely logging at the same rate as before LES control would lead to continued soil erosion, surface water contamination, and an imbalance of biological diversity. The removal of all trees on the site would expose soils to weather elements and increased erosion. Increased sediments will potentially affect susceptible surface water bodies in the area, as previous heavy timbering activities have affected suspended solids in Lake Avalyn and Bluegill Pond. Truck movements and associated air and noise pollution would be higher than those predicted for CEC, and increased traffic by loggers and logging trucks will have about the same short-term impacts as the proposed action on local roads and residents.

Socioeconomically, the no-action alternative would perpetuate the depressed economic conditions in the area and result in a likely continued outmigration of skilled and higher-income workers. The region would continue to depend on its current commercial, industrial, and agricultural base.

Statewide, the impact of the no-action alternative is the failure to obtain a minimum of 450 jobs per year during construction and 600 jobs per year during full operations (annual averages, including multiplied effects). The actual employment impacts (and thus job opportunities lost) may be substantially higher than these values because of the high absolute and per-worker expenditures and revenue at CEC.

Nationally, the impacts of the no-action alternative would be: (1) no change in the pressure on other enrichment suppliers to maintain competitive positions in the world enrichment market; (2) loss of an additional domestic supplier to reduce potential dependence on foreign sources; and (3) loss of the opportunity to substitute an energy-efficient process for the older gaseous diffusion process.

4.5 Cost-Benefit Analysis

This section presents and discusses a cost-benefit analysis of the LES facility and concludes that it is a large net benefit to the region and to Louisiana. Regional benefits are primarily in the form of high-paying construction and operations jobs (averaging $37,000 and $44,400, respectively, including benefits, 1990 dollars) in an area with average earnings about half those levels and high unemployment and underemployment. Analysis of the statewide multiplier effect of the construction and operations payrolls suggests a benefit to Louisiana (from payroll earnings only) of almost $18 million per year during the construction phase and $17 million per year during the operations phase. This estimate, which may significantly understate the actual multiplied earnings, includes the direct earnings at CEC and the

indirect earnings from secondary economic activity. LES estimates multiplied earnings of $20-21 million. This estimate is not unreasonable. (The effect during each year of the 7-year D&D period is expected to be no more than 15 percent of a typical year during operation.)

The regional employment benefit begins with an annual average of 200 construction jobs over 6 years (averaging 275 per year for the peak years) and 180 operations jobs. Multiplied construction and operations jobs across Louisiana are certain to exceed 450 per year and 600 per year, respectively. Because of the very high absolute and per-worker expenditures at CEC, the employment impacts will be higher than these minimum levels. Section 4.5.1 discusses these issues.

On a State output basis, the multiplied value of the $855 million direct investment and the $165 million/year output are estimated at a maximum of $19 billion and $330 million/year, respectively (1990 dollars). These estimates derive from the direct and indirect effect on Louisiana of the total spending to construct the facility and the total revenue received from product sales. The multiplied economic outputs in Louisiana, however, are likely to be considerably lower than these values. As discussed in Section 4.5.1, estimate of state output based on final-demand multipliers overstate the economic impact of CEC on Louisiana. At the same time, multiplied economic outputs would be increased by LES' spending on contingencies, capitalized interest, escalation, and other factors not included in the $855 million direct investment estimate.

Although the total benefit to the State from the CEC payroll is large, the distribution of benefits is likely to be concentrated in the middle income groups. Adherence to the employment provisions of the Louisiana Enterprise Zone Act (see Section 4.2.1.7.2) will significantly benefit lower income individuals. However, a complete diffusion of benefits to the bottom of the income and employment distribution is unrealistic. Studies show that higher-income households benefit most from the income generation process. This outcome is a function of the spending patterns of the higher-income and lower-income households in the U.S. and is not related to CEC, *per se*. Lower-income households spend a higher percentage of their income on goods and services supplied by higher-income households than vice versa. The employment opportunities from CEC should benefit all economic groups.

Because the CEC facility is extremely capital-intensive and has low operating costs, it will likely be operated for its lifetime even if it is uneconomical on a full-cost recovery basis. Once the fixed costs of the construction have been incurred, they will not affect the decision to continue operation. Operations would probably continue, even if the plant cannot cover its fixed costs since operations would more than cover variable costs, including the decommissioning trust. As long as the plant covers its variable costs (and thus makes a contribution to fixed costs), it is economical to continue operation. While the plant may not generate taxable income (because of high debt service), property tax revenues (possibly at

a reduced level) and employment for operations personnel should be realized. Similarly, the multiplied effects of continued operation should be realized.

With one exception, costs to Claiborne Parish and the region from hosting the facility are expected to be minimal. No significant impacts are expected in any local infrastructure areas (e.g., schools, housing, water, sewer), and no significant influx of migrants to a concentrated area is likely. Road repair may be necessary on a more frequent basis. In general, the costs will be diffused sufficiently to be indistinguishable from normal, although rapid, economic growth.

The exception appears to be public safety. Even without a boomtown effect, crime can be expected to increase because of the influx of additional residents and increased general economic activity. The high wages offered by LES, the relative lack of traditional amenities in the area, and the high local unemployment and underemployment, suggest that Claiborne Parish may need additional law enforcement personnel to address the increased public safety demand during any large-scale influx of new workers, transients, and secondary economic migrants.

4.5.1 Input-Output Multipliers

Construction, operation, and decommissioning of the LES facility will have economic effects in the State beyond those at the facility itself. These secondary economic effects include generation of output in other industries, circulation of wage income, and job creation in support industries. The cumulative effect of the direct economic activity thus translates into a multiplied regional effect. Economists use regional input-output (I-O) multipliers for output, earnings, and employment to measure the effects of changes in economic activity. These multipliers may be estimated at the level of the nation, the State, or the region (e.g., one or more parishes) and may be estimated for hundreds of economic activities in the areas of construction, manufacturing, trade, transportation, etc.

A standard approach to estimating multiplied impacts is the use of the U.S. Department of Commerce's Regional Input-Output Modeling System (RIMS II) (Department of Commerce, 1994 and 1992c). RIMS II reports multipliers for final-demand and direct-effects. Final-demand earnings multipliers measure total (direct and indirect) dollar changes in earnings in households employed in the State for each additional dollar of output delivered to final demand. Final-demand employment multipliers measure total (direct and indirect) changes in the number of jobs in State industries for each one million dollars of output delivered to final demand. Final-demand output multipliers measure total (direct and indirect) changes in State output for each dollar of output delivered to final demand. Direct-effect multipliers measure the direct-effect of a job or a dollar of earnings (not output) in a particular industry.

The categories chosen for the multiplier analysis are construction of industrial buildings (I-O Industry Number 11.0201) and manufacturing of industrial inorganic chemicals (I-O

Industry Number 27.0104). Table 4.25 shows the final-demand and direct-effects multipliers in these industry categories for Louisiana.

Table 4.25 RIMS II Input-Output Multipliers for Louisiana (Department of Commerce, 1994 and 1992c)

Multiplier Category	Industry Category	Final-Demand Multiplier	Direct-Effects Multiplier
Earnings	Construction, Industrial Buildings	0.78	2.08
Earnings	Manufacturing, Industrial Inorganic Chemicals	0.49	2.12
Employment	Construction, Industrial Buildings	37.3	2.16
Employment	Manufacturing, Industrial Inorganic Chemicals	17.8	3.20

The first line of the table says that $1 of industrial building construction in Louisiana produces a multiplied value of $0.78 on all types of earnings (construction and nonconstruction) in the State. Similarly, $1 of output in the industrial inorganic chemical industry generates $.49 of earnings in the State. For employment, each million dollars of construction spending to final demand (1989 dollars) generates 37.3 jobs. Each million dollars of industrial inorganic chemical output generates 17.8 jobs.

The direct-effects multiplier column says that each $1 of earnings in industrial building construction generates an additional $1.08 in total in-state earnings ($2.08 total). In the industrial inorganic chemical industry, each $1 generates an additional $1.12 ($2.12 total). Similarly, each job in construction generates 1.16 additional jobs, for a total of 2.16 jobs. Each job in inorganic chemical manufacturing generates a total of 3.2 jobs.

The conventional interpretation of the 0.78 final-demand multiplier is that the $855 million construction project (averaging $143 million/year over 6 years) would result in a direct and indirect earnings impact throughout the State of $112 million/year (over the same 6 years). The conventional interpretation of the operational earnings multiplier is that the $165 million annual value of LES' output would translate into $165 million x 0.49 or $81 million in earnings each year of full operations.

For employment (including CEC jobs), the final-demand multiplier implies 37.3 jobs per million dollars (1989 dollars) of construction, or around 5,100 jobs (using 1989 dollars). For operations, the final-demand multiplier implies about 2,800 jobs.

Use of the direct-effects multiplier implies fewer than 450 jobs per year on average from construction (i.e., about 2.16 times the number of direct construction jobs) and fewer than 600 jobs per year from operations (i.e., about 3.2 times the number of direct operations jobs).

For payroll expenditures, the direct-effects multiplier suggests total annual earnings of about $17.7 million from construction ($8.5 direct and $9.2 indirect) and about $17 million from operations ($8.0 direct and $9.0 indirect). Tables 4.26 and 4.27 summarize these results. There is no direct-effects multiplier for total state output.

Table 4.26 Estimated Impacts Based on RIMS II Final-Demand Multipliers (Department of Commerce, 1994 and 1992c)

	Construction (6 years)	Operations (30 years)
Dollars to Final Demand	$143 million/yr	$165 million/yr
Multiplied Earnings	$112 million/yr	$81 million/yr
Multiplied Employment	5,100/yr	2,800/yr

Table 4.27 Estimated Impacts Based on RIMS II Direct-Effect Multipliers (Department of Commerce, 1994 and 1992c)

	Construction (6 years)	Operations (30 years)
Direct Earnings	$8.5 million/yr	$8.0 million/yr
Direct Employment	200/yr	180/yr
Multiplied Earnings	$17.7 million/yr	$17.0 million/yr
Multiplied Employment	450/yr	600/yr

As Tables 4.26 and 4.27 show, the final-demand and direct-effects multipliers yield widely differing conclusions about earnings and employment. In reality, the multiplied earnings and employment effects are likely to resemble but exceed the direct-effects values (Table 4.27).

The larger estimates in Table 4.26 (final-demand) are misleading because a disproportionately large fraction of CEC's per-worker expenditures and revenue will be spent out-of-state. The out-of-state spending, including, for example, centrifuges, is almost certainly larger than that for ordinary industrial building construction or chemical manufacturing. On the other hand, the estimates in Table 4.27 (direct-effects) are likely to be too low because of the disproportionately high absolute and per-worker construction expenditures and revenue. The positive effect of the high absolute and per-worker expenditures and revenues is likely to exceed the negative effect of the out-of-state spending.

(RIMS II accounts for typical levels of in-state and out-of-state spending by industrial category. A centrifuge enrichment plant is not typical and thus must be reviewed more analytically.)

As the variability of the estimates makes clear, multiplied values should not be regarded as precise estimates but rather as general indicators. Variations in spending from year to year, changes in procurement patterns, availability of expensive capital equipment within the State, definition and allocation of expenditures among RIMS II categories, changes in actual commercial relationships since the most recent multiplier estimation, changes in State and Federal taxation and regulation, ordinary marketplace variability, and numerous other factors make precision impossible.

The values in Tables 4.26 and 4.27 can be compared to LES' payroll-only multiplier approach based on an analysis of parish-by-parish primary and secondary income and jobs generated. LES (LES, 1992h) concluded as follows:

> The socioeconomic benefits from the project were estimated to be CEC payroll expenditures for both the construction and operational phases plus the additional secondary trade and services income induced through the economic multiplier. The estimated Claiborne Parish multiplier is 2.673 if all the workers reside in Claiborne Parish and 2.817 if the workers live in several parishes throughout the labor supply area. If all the workers reside in Claiborne Parish, it will induce yearly benefits of $1.538 million in secondary sector income (construction, transportation, communications, and public utilities), $1.389 million in trade sector income, $0.299 million in finance/insurance/real estate income, $1.357 million in service sector income, and $7.965 million in other sector income. Given an average nonmanufacturing per-job earnings rate of $15,059, this should induce as many as 833 low-skill jobs that basically could be filled by presently unemployed persons in Claiborne Parish.
>
> Total economic benefits (based on construction and operations payrolls only) are estimated at $20.0 million if all the workers live in Claiborne Parish and $21.1 million if the workers are diffused throughout the area.

Thus LES' parish-by-parish payroll-only approach produces results that are generally similar to estimates derived from the RIMS II direct-effects multiplier analysis. The direct-effects earnings estimates from RIMS II are about $17-18 million compared to LES' $20-21 million. The direct-effects employment estimates are about 450 for construction and 600 for operations, compared to LES' estimate of just over 1,000 (including the jobs at CEC). Since the direct-effects multipliers discussed above understate the actual earnings and employment impact of CEC (because of the extremely high absolute and per-worker construction cost and revenue stream), LES' estimates are not unreasonable.

Use of RIMS II final-demand output multipliers for industrial building construction and industrial inorganic chemical manufacturing implies total multiplied output of $1.9 billion for construction and $330 million/yr for operations. This is based on final-demand output multipliers of 2.27 and 2.01 for the construction and manufacturing categories, respectively, direct construction costs of $855 million, and revenue of $165 million/year.

RIMS II notwithstanding, it is unlikely that actual multiplied output will be $1.9 billion from construction and $330 million/year from operations. The very high levels of construction costs per worker and revenue per worker and the very specialized nature of the technology and raw materials imply larger out-of-state expenditures for CEC than are representative of industrial building construction and industrial inorganic chemical manufacturing in Louisiana. The potential for overstating multiplied output using the RIMS II final-demand multipliers can be inferred by comparing the final-demand estimates of employment and earnings in Table 4.26 with the much lower direct-effects estimates in Table 4.27. (There is no direct-effects multiplier for output.) As the discussion accompanying these tables suggests, the multiplied in-state effect of CEC is much more likely to resemble the direct-effects values than the final-demand values.

On the other hand, multiplied output associated with construction would be increased by in-state spending for costs not included in the $855 million direct-cost estimate. Costs associated with escalation, capitalized interest, contingencies, and certain other factors would all increase total state output. On the whole, construction and operation of CEC will produce a large multiplied increase in state output but less than the $1.9 billion (construction) and $330 million/year (operations) values implied by the RIMS II final-demand multipliers.

4.5.2 Property Values and Amenities

LES is likely to have a significant effect on local housing values and, ultimately, amenities. There is considerable evidence to suggest that property values and amenities are enhanced in counties with large industrial taxpayers (e.g., fossil power plants) (Gamble and Downing, 1982). These benefits are not only via the direct payment to the taxing jurisdiction, but through the increased value of real property as the benefit stream to the property owners is capitalized into property values. The 10-year property tax abatement will mitigate this effect to some degree.

The facility is likely to increase both housing and land prices because of increased demand (e.g., from migrants) and because of the benefit-capture effect just described. This is a benefit to all existing property owners, including those acquiring property prior to the actual receipt of the tax revenues. The magnitude of the benefit is difficult to quantify but is not negligible. Real estate prices in the area are likely to be bid up in anticipation of the property tax stream.

4.5.3 Tax Revenues

Property taxes for the first 10 years of plant life are estimated at $5,400/year, based on 1 percent of the land cost. LES' 10-year tax abatement would apply to the CEC facility site anywhere in Louisiana. Post-abatement taxes are estimated at $7.9 million/year, based on 0.75 percent of the initial book value of the facility. LES will also pay a one-time Claiborne School Board tax of about $5 million (LES, 1992h).

Primarily because of high depreciation and interest charges, the project is projected to have cumulative taxable losses for income taxes through 2005. LES forecasts nominal annual tax liabilities after 2005 ranging from $5 million to $130 million. As discussed in Section 4.5.5, the realization of high tax liabilities could be affected by the competitiveness of the enrichment market.

4.5.4 New Jobs and Increased Local Income

The facility will employ an average of about 200 construction people per year for 6 years and an average of 180 operations people over the 30-year life of the facility. Average annual earnings, including benefits, are estimated at about $37,000 and $44,400 for construction and operations workers, respectively. LES estimates that 85 percent of the construction workers and probably an equal or greater percentage of the operations workers will be existing residents of the 24-parish labor pool. LES' adherence to the employment provisions of the Louisiana Enterprise Zone Act will increase the construction and operations employment opportunities of the existing residents of Claiborne Parish and, to a lesser extent, other nearby parishes. Operational jobs can be mostly filled with local workers because the required skills mix at the facility is similar to that for other heavy chemical or industrial facilities in the 24-parish area. Only the radiological and specialized chemical or nuclear-related jobs are unlikely to be filled by local residents. Shorter-term construction jobs, especially high-skill construction jobs, are more likely to attract temporary workers from outside the area. The high wage rate proposed by LES will be an especially strong magnet for outside workers. As outlined in Section 4.2.1.7.2, LES must employ people in accordance with the Louisiana Enterprise Zone Act. Adherence to this act's requirements will confer significant employment benefits on a significant number of generally lower income or previously unemployed individuals and existing residents of Claiborne Parish. Decommissioning jobs are likely to resemble operations jobs, but at no more than 15 percent of the level during operations.

4.5.5 Overall Project Economics

LES estimates the direct capital cost of the plant, including interest, property tax, and transmission facilities, to be approximately $855 million (LES, 1992h). Escalation, capitalized interest, contingency, decommissioning, and replacement centrifuges raise the total investment to about $1.6 billion (1990 dollars) (LES, 1992h). Operating costs are not included in this estimate.

The ultimate realization of these estimated costs depends on numerous factors, some of which are outside LES' control (e.g., regulatory factors). Other factors depend on the experience of LES and its partners. Urenco has experience building and operating gaseous centrifuge enrichment plants. Urenco has built and operates gaseous centrifuge enrichment plants in Capenhurst (U.K.), Almelo (The Netherlands), and Gronau (Germany). In addition, LES partners' parent companies have significant experience in the construction and operation of nuclear and other large industrial facilities in the U.S. For example, Duke Power Company, Northern States Power Company, and the Louisiana Power and Light Company operate 11 nuclear power plants. Fluor Daniel is a major architect-engineering firm that has built large industrial facilities worldwide. This experience should help the partners to control costs. The absence of any experience (by any commercial entity) in constructing centrifuge enrichment plants in the U.S. still creates project uncertainties and may lead costs to exceed contingencies.

On the revenue side of the income statement, there is some question about the commercial viability of CEC. As discussed in Section 1.4, in May 1993, the U.S. agreed to buy LEU containing the equivalent of 5.53 million SWUs per year from Russia during the 1999-2013 period. This period approximately coincides with the first 15 years of CEC production. The Russian supplies represent about 15 percent of projected world SWU demand or more than 50 percent of projected U.S. demand.

If LES constructs the CEC, it would be one of the lowest variable cost SWU suppliers in the world. Because of its low variable costs, CEC would operate under most world SWU supply scenarios. Thus, the employment benefits are likely to be maintained under most scenarios. Because of the potentially large price-depressing impact of the Russian LEU sales, the plant runs a high risk of not being able to cover fixed charges (including an equity return). Under these conditions, the plant would earn no taxable income, pay no income taxes, and ultimately become insolvent. This insolvency would trigger defaults and asset writedowns that could reduce property tax payments. The ability of CEC to fund the decommissioning trust out of operating income (before debt service) would not be affected.

4.5.6 Impact on the Local Government for Services Required

The staff concludes that the costs the project will impose on the local government for required services are minimal. Impacts are expected to be very small in the areas of: housing; housing prices (except as noted in Section 4.1.5); noise or aesthetic disturbances; overloading of water supply and sewage treatment facilities; crowding of local schools, hospitals or other public facilities; or the overtaxing of community services. In particular, this report notes the current excess of public educational infrastructure in the area (partly a remnant of the collapsed oil and gas market and the out-migration of families) and the relatively small number of in-migrant children compared to the existing school-age population.

Larger potential impacts are possible on the police and justice systems. The construction phase at CEC and the transitions from construction to operations and from operations to D&D are likely to show an increase in the transient population, dislocations associated with crime, and changes in levels of undesirable activities. The local jurisdictions should be aware of these potential effects, none of which are unique to CEC, Claiborne Parish, or Louisiana.

4.5.7 Value of Enriched Uranium

At full output, CEC would produce 1.5 million SWUs of enriched uranium per year. Based on a 1990 market price of $110/SWU, the value of the uranium enrichment service would be approximately $165 million/year.

4.5.8 Summary

On balance, CEC should be a major socioeconomic asset to Homer, Claiborne Parish, and neighboring parishes. A relatively large number of high wage jobs will be provided in an economically depressed region. The negative impacts of CEC are likely to be similar to those of any relatively large-scale socioeconomic development in a small, rural area. These include possible increased crime, changes in quality of life, and changes in property values (some positive, some negative) that some existing residents may find undesirable. Radiological and chemical impacts from the facility are expected to be minimal. Aside from the crime issue and property values, the costs of CEC to the local population and municipalities should be minimal.

5.0 EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

This section discusses the radiological and nonradiological environmental and effluent monitoring programs to be conducted before facility startup and after the commencement of operations. Federal and State requirements are identified and compared with the proposed CEC programs to determine adequacy. The effluent and environmental monitoring programs provide indication of leakage from process systems and quantification of actual impacts of facility operation. Sections 6.4 and 8.3 of the LES Safety Analysis Report (SAR) provide more details about the proposed effluent control and monitoring systems (LES, 1993a).

5.1 Preoperational Environmental Monitoring Programs

5.1.1 Fugitive Emissions Monitoring

If a license is granted for construction and operation of the CEC, fugitive dust and hydrocarbon emissions such as diesel exhaust may result from earthmoving and other construction activities at the site (see Section 4.1.6). However, as discussed in Section 4.1.6, the emissions are expected to be too small to require formal monitoring.

5.1.2 Radiological Environmental Monitoring Program

The preoperational program will focus on collecting data to establish baseline information useful in evaluating future changes in potential environmental conditions caused by CEC operation. The data will help support critical pathway analyses, including selection of nuclide/media combinations to be encompassed into the operational surveillance program. Radionuclides will be identified using technically appropriate, accurate, and sensitive analytical equipment. The proposed preoperational program is designed to be more extensive than the operational program in order to provide a broad knowledge able to accommodate changing conditions around the site during construction, operation, and eventual decommissioning, as well as adapt to changing regulatory requirements. This base of knowledge can help assess the proper operation of containment and effluent controls in a licensed facility as well as radiological impacts on site environs, estimate potential impact on members of the public, and determine compliance with applicable radiation protection standards.

This program will be initiated at least 2 years prior to the operation of the facility in order to develop a sufficient data base for comparison with the proposed operational radiological monitoring program as well as to provide experience for improvement. Table 5.1 describes the preoperational and operational radiological monitoring programs. As proposed, samples of ambient air, surface water and groundwater, soil, sediment, and vegetation will be collected and sent to a qualified laboratory for analysis through a reliable shipper. Sample transmittal forms will accompany each shipment. Samples will be packed to ensure integrity

Table 5.1 Summary of Preoperational[a] and Operational Environmental Radiological Monitoring Sampling Programs and Locations at Proposed CEC Site (LES, 1994a and 1994c)

Pathway/Sample Type	Samples and Locations	Sampling Frequency and Collections
Airborne Particulates	AP1 - One sample located in the sector with the highest prevailing wind direction. To be located in the area with the highest χ/Q for that sector near the site boundary.	Air sampler with a particulate filter, operating continuously, collected and analyzed weekly.
	AP2 - One sample located in the sector with the second highest prevailing wind direction. To be located in the area with the highest χ/Q for that sector near the site boundary.	Also, for site AP3, isotopic analysis for ^{234}U, ^{235}U, and ^{238}U shall be conducted on a semiannual composite sample during operation.
	AP3 - One sample located near the resident who is maximally exposed from the gaseous pathway.	
	AP4 - One sample located in the west sector. To be located near the site boundary corresponding to the highest χ/Q in that sector.	
	AP5 - One sample located in the east sector near the site boundary corresponding to the highest χ/Q in that sector.	
	AP6 - One sample located in the south sector near the site boundary corresponding to the highest χ/Q in that sector. The locations of the airborne particulates sampling are shown in Figure 5.1.	
	AP7 - One sample located in the north sector near the site boundary, corresponding to the highest χ/Q for that sector. If this sector is already represented by another air sampling site, then AP7 will not be needed.	
Airborne/Soil	S1-S16 - Samples to be collected near the site boundary in each sector. One sample per sector.	Preoperational grab samples collected and analyzed quarterly; operational grab samples collected semiannually. Combine samples from 16 sectors into 4 composites[b].

Table 5.1 Summary of Preoperational[a] and Operational Environmental Radiological Monitoring Sampling Programs and Locations at Proposed CEC Site (LES, 1994a and 1994c) (Continued)

Pathway/Sample Type	Samples and Locations	Sampling Frequency and Collections
Airborne/Vegetation	V1-V16 - Samples to be collected near the site boundary in each sector. One sample per sector.	Preoperational grab samples collected and analyzed quarterly; operational grab samples collected semiannually at the same time as soil sample collection. Combine samples from 16 sectors into 4 composites[b].
Liquid/Groundwater	GW1 (Well #A1), Preoperational only, see Figure 5.2 for well locations[c]. GW2 (Well #B1) GW3 (Well #C1) GW4 (Well #D1), Preoperational only GW5 (Well #E1)	Preoperational grab samples to be collected and analyzed quarterly; operational grab samples to be collected and analyzed semiannually.
Liquid/Surface Water	SW1 - Inflow to Lake Avalyn; see Figure 5.3 for surface water sampling locations. SW5 - Inflow to Bluegill Pond SW6 - Bluegill Pond, near the center SW7 - Outflow from Bluegill Pond SW8 - Site Drainage stream SW9 - Outflow at the western property boundary SW11 - Hold-up Basin, Preoperational only SW12 - Inflow of Cypress Creek to Lake Claiborne	Preoperational grab samples to be collected and analyzed quarterly; operational samples collected continuously to obtain monthly integrated composites.
Liquid/Shoreline Sediment	SS1 - To be collected near the outflow of Bluegill Pond. SS2 - To be collected near the inflow of Bluegill Pond from the Hold-Up Basin. SS3 - To be collected near the south shore of Bluegill Pond. SS4 - To be collected near the north shore of Bluegill Pond. SS5 - To be collected near surface water site at Lake Claiborne.	Preoperational grab samples collected and analyzed quarterly; operational grab samples (composite) collected and analyzed semiannually.

Table 5.1 Summary of Preoperational[a] and Operational Environmental Radiological Monitoring Sampling Programs and Locations at Proposed CEC Site (LES, 1994a and 1994c) (Continued)

Pathway/Sample Type	Samples and Locations	Sampling Frequency and Collections
Liquid/Bottom Sediment	BS1 - To be collected from the east end of Bluegill Pond. BS2 - To be collected from the center of Bluegill Pond. BS3 - To be collected from the west end of Bluegill Pond. BS4 - To be collected from the center of the Hold-Up Basin. BS5 - To be collected near surface water location at Lake Claiborne.	Preoperational grab samples; collected and analyzed quarterly; operational grab samples (composite) collected and analyzed semiannually.

[a] "Preoperational" is defined as from the beginning of site preparation up to the receipt of licensed source material.
[b] Sectors shall be combined as follows:
Composite 1 = sectors N, NNE, NE, ENE
Composite 2 = sectors E, ESE, SE, SSE
Composite 3 = sectors S, SSW, SW, WSW
Composite 4 = sectors W, WNW, NW, NNW
[c] LES redesignated preoperational wells GW2, GW3, and GW5 as GW1, GW2, and GW3 for the operational program; to avoid confusion this is not reflected in this EIS.

during transit, and perishable samples will be refrigerated as necessary. Samples requiring long-term compositing will be stored in a manner to ensure their integrity until the composite analysis is performed. During the course of the program, improvements to the program or unforeseen changes to the sampling sites may be made. The rationale and actions behind such decisions will be documented, and any changes to the required program will require NRC approval.

The proposed atmospheric radioactivity monitoring program was developed on the basis of plant design data, demographical and geographical data, meteorological data, land use data, and projected radioactive effluent estimates to determine the expected concentrations and deposition of airborne radioactivity in the environment around the facility as a result of operation. The background data will then be used to determine the incremental increase in committed effective dose equivalent (CEDE) attributed to facility operation. Because the anticipated operational releases are expected to be very low and will rapidly dilute by dispersion, it will be difficult to detect small increases in naturally occurring uranium in the environs. Therefore, the majority of the air monitoring sites will be in the prevailing wind direction and within 1.6 kilometers (1 mile) of the facility. The sampling filters will collect

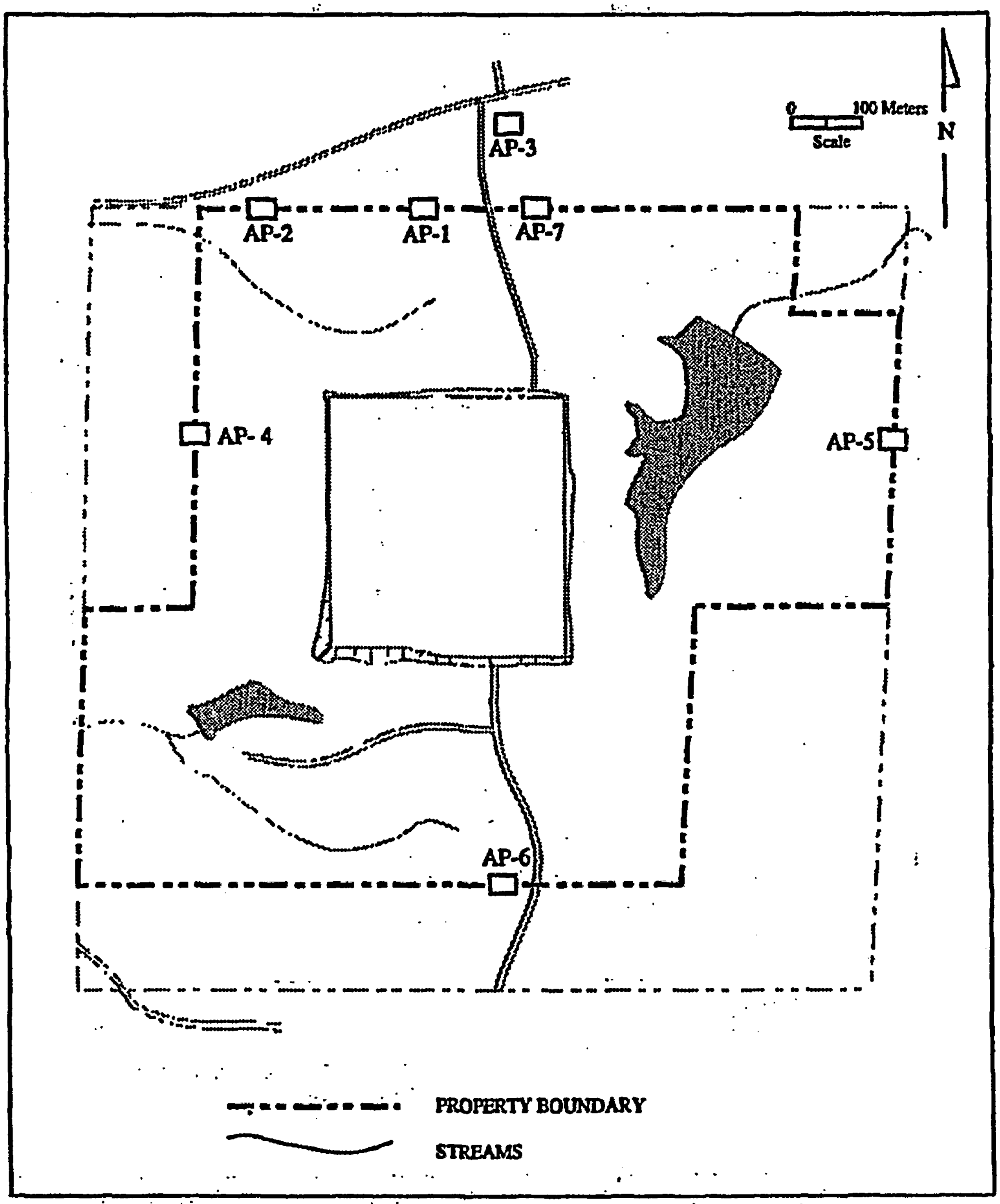

Figure 5.1 Air Particulate (AP) Sampler Locations at CEC (LES, 1994a)

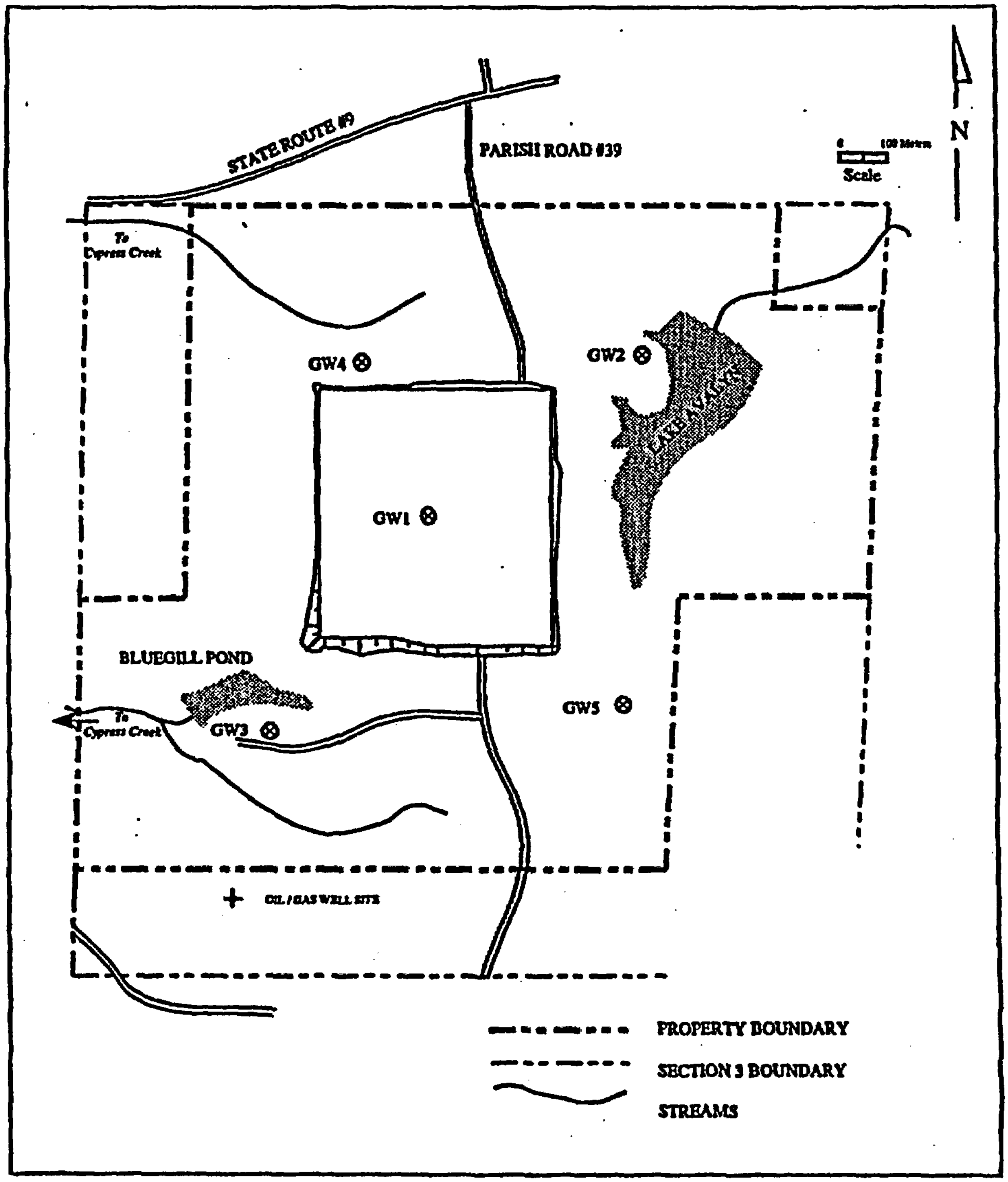

Figure 5.2 Location of Groundwater (GW) Radiological Monitoring Sampling Points at CEC (LES, 1994a)

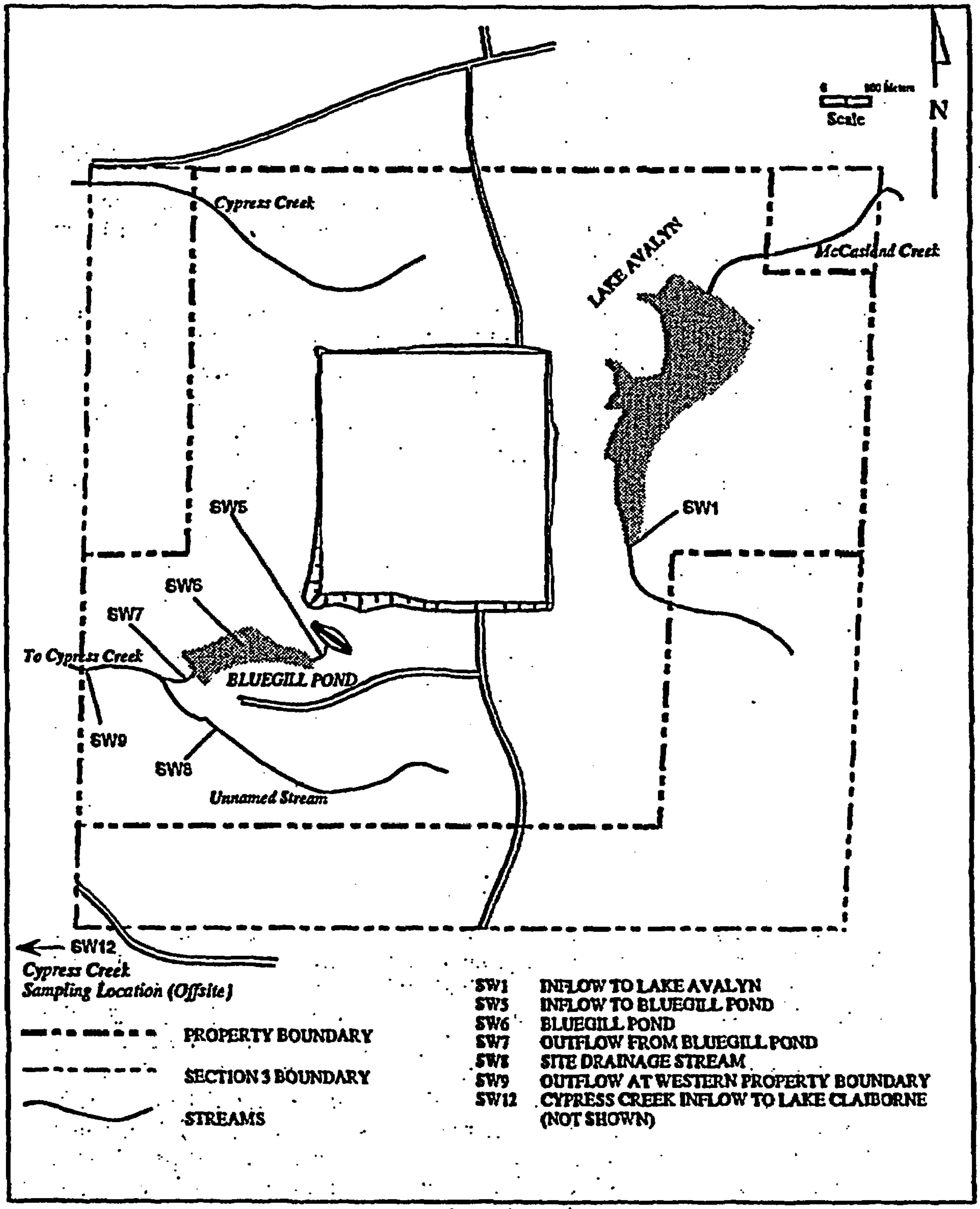

Figure 5.3 Location of Surface Water (SW) Radiological Monitoring Sampling Points at CEC (LES, 1994a)

a fraction of the radioactive particles that may be released to the atmosphere during future operations, and the fraction collected at any given location will depend upon meteorological conditions during the sampling period. Air samples from the site boundary will be continuously collected for weekly gross alpha counts for each collection site. CEC has committed to re-evaluating the location of airborne radioactivity sampling stations within 66 months after commencement of the onsite meteorological monitoring program and every 5 years (66 months maximum) thereafter. Any necessary changes shall be made within 6 months of the re-evaluations (LES, 1994c).

The proposed lower limits of detection (LLD) for gross alpha in the various media to be sampled are shown in Table 5.2. The LLD, 3.7×10^{-14} Bq/ml (1.0×10^{-18} μCi/ml) for air (if all due to uranium), is less than 3.3 millionth of the most restrictive solubility class in the 10 CFR Part 20, Appendix B, Table 2 limit for each uranium nuclide. Background levels of uranium in air are on the order of 7.4×10^{-13} Bq/ml (2×10^{-17} μCi/ml) (NCRP, 1987b). Because these LLD will permit detection of background levels of uranium in air, NRC concludes that the LLD are acceptable for the atmospheric radiological environmental sampling programs at LES.

Table 5.2 Proposed Lower Limits of Detection (LLD) for Gross Alpha for Environmental Monitoring Analyses (LES, 1994c)

Sample Type	LLD	
	Bq/ml or g	μCi/ml or g
Water	3.7×10^{-8}	1.0×10^{-12}
Air	3.7×10^{-14}	1.0×10^{-18}
Soil/Sediment	1.1×10^{-2}	3.0×10^{-7}
Vegetation	3.7×10^{-6}	1.0×10^{-10}

Trace amounts of radioactive materials may also be contained within Bluegill Pond and the Hold-Up Basin. To assess the background levels of uranium in the liquid pathway, surface water will be sampled quarterly from both of these water bodies, as well as from Lake Avalyn, Cypress Creek, and connecting streams as shown in Figure 5.3. Groundwater sampling will be based on available hydrological data. Groundwater will be sampled from at least one well on the site, at one residence or business less than 3 kilometers (2 miles) from the facility in a location where groundwater can be potentially affected by operation of the facility, and at other groundwater wells as shown in Figure 5.2. Groundwater wells will identify any changes in the elevation and flow direction and permit shallow aquifer monitoring in all directions hydraulically downgradient from the facility. Deep groundwater from the Sparta Sand Aquifer will also be monitored from the two onsite facility water supply wells and the offsite Central Claiborne Water System well. As stated in Table 5.2, the gross alpha (assumed to be uranium) LLD for water samples is 3.7×10^{-8} Bq/ml

(1.0×10^{-12} μCi/ml), which represents 3.3×10^{-6}th of the most restrictive 10 CFR Part 20, Appendix B, Table 2 limit for each uranium nuclide. Because background levels of uranium in water are on the order of 3.7×10^{-7} Bq/ml (1.0×10^{-11} μCi/ml) (NCRP, 1987b), NRC concludes that the LLD will enable CEC to detect background levels of uranium in water and represent an acceptable water monitoring program. In addition, LLD at this level would help ensure compliance with the EPA's proposed uranium drinking water limit of 1.11 Bq/l (30 pCi/l) during the operational period.

As noted in Table 5.1, soil sampling will be performed quarterly in all 16 compass sectors, and composited into 4 samples. Sediments in the Hold-Up Basin, Bluegill Pond, and Lake Claiborne will be sampled quarterly as shown in Table 5.1. Background levels of uranium in soil are on the order of 6.6×10^{-2} Bq/g (1.8×10^{-6} μCi/g) (NCRP, 1987b). The proposed LLD for gross alpha (assumed to be uranium) in soil or sediment is 1.1×10^{-2} Bq/g (3.0×10^{-7} μCi/g), which corresponds to 1 percent of the current NRC Branch Technical Position for burial of uranium-contaminated soil onsite that can be released for unrestricted use following decommissioning of a facility (NRC, 1981a). NRC regards this LLD as adequate for a newly licensed uranium operation because it would permit detection of background levels of uranium in soil or sediment with reasonable statistical certainty.

Vegetation sampling will also be conducted quarterly near the soil sampling locations around the site boundary, as noted in Table 5.1. The 16 compass sector samples will be composited into 4 samples using the same scheme as for soil. As shown in Table 5.2, the gross alpha LLD (assumed to be uranium) in vegetation is 3.7×10^{-6} Bq/g (1.0×10^{-10} μCi/g). Because background levels of uranium in vegetation are on the order of 3.7×10^{-5} Bq/g (1.0×10^{-9} μCi/g) (NCRP, 1987b), NRC concludes that the proposed LLD for the CEC preoperational monitoring program for vegetation will permit CEC to detect background levels of uranium with reasonable statistical certainty.

5.1.3 Nonradiological Environmental Monitoring Program

Nonradiological gaseous and liquid effluents, while not within NRC's regulatory purview, must meet the appropriate Federal and State standards. CEC has no identified monitoring program for nonradioactive effluents released to the atmosphere. CEC operations are not classified as a major source generation under Clean Air Act (CAA) definitions; however, CEC is required to file for an air quality permit under the LDEQ air regulations. This permit will identify any air quality monitoring program to fulfill the permit requirements. The proposed CEC monitoring and sampling program for chemicals in liquid effluents is described in the NPDES Application to EPA and the Discharge Wastewater Permit Application to LDEQ (LES, 1992e). Proposed administrative and expected regulatory limits for chemicals in sewage treatment discharge water are presented in Table 4.10. To demonstrate compliance with these standards, LES could be required to collect and analyze representative samples; however, LES is committed to meeting these standards and will be required to do so in order to receive the necessary approvals for nonradiological discharges. When these standards are met, no significant impacts can reasonably be expected to occur.

Chemical constituent quantities, which will be discharged to the natural environment in facility effluents, will be maintained below concentrations established by the State of Louisiana and Federal regulatory agencies as protective of human health and the natural environment.

Surface water samples have been collected at several locations within and outside the plant site and analyzed to establish site "baseline" water quality conditions. The shallow onsite groundwater and the deep Sparta Aquifer zone underlying the site have also been chemically measured to establish "baseline" groundwater quality conditions of the facility site. Collection locations and tabulations of this baseline information are presented in Sections 3.3.1 and 3.3.2 of this EIS.

Prior to facility operation and continuing on a quarterly basis thereafter throughout the life of the plant, additional ground and surface water samples will be collected, analyzed, and compared to the baseline data to monitor any impact facility operations might have on water quality. For both surface water and groundwater, a list of the physiochemical parameters that will be analyzed, along with the expected analytical methodologies for each, is presented in Table 5.3.

Waters to be analyzed include lakes, ponds, streams, groundwater, and stormwater. Physiochemical data will be collected from the two water bodies onsite, Lake Avalyn and Bluegill Pond, including nutrient and mineral content, dissolved oxygen, pH, alkalinity, specific conductance, temperature, and water level. Except for nutrient and mineral content, all other parameters will be measured on a quarterly schedule to document seasonal fluctuations prior to plant operation. Width, depth, and velocity measurements will be taken for the streams in the area. Groundwater samples will be analyzed for particle size distribution, bulk density, porosity, and total organic carbon. Monitoring wells have been installed on the property to retrieve these samples. Slug tests will be performed on each of the wells to obtain hydraulic conductivity estimates. Two- and three-dimensional shallow groundwater level contouring will be performed for the area of the site. Deep groundwater will be evaluated for the possible effects of anticipated water withdrawals from the Sparta Aquifer. Prior to facility operations, measurement of water levels in representative preoperational survey wells will continue on a quarterly schedule to document the seasonal range of groundwater fluctuations at the site.

The stormwater monitoring program will be initiated during construction of the facility. Stormwater monitoring during facility construction will be conducted annually and used to evaluate the effectiveness of measurements taken to prevent the contamination of stormwater and to retain sediments within property boundaries. The Hold-Up Basin will be used as a sediment detention basin during construction, and the construction phase stormwater monitoring will be conducted at the discharge from the Hold-Up Basin to Bluegill Pond. As shown in Table 5.4, the preoperational stormwater monitoring program will require measurement of oil, grease, total suspended solids (TSS), biochemical oxygen demand (BOD) over 5 days, chemical oxygen demand (COD), phosphorus, nitrogen, pH, and nitrates in an annual grab sample.

Table 5.3 Surface Water/Groundwater Chemistry Monitoring Program (LES, 1994a)

Physiochemical Measurement	Analytical Methodology
Temperature	Thermistor Thermometer
pH	Electrode
Conductivity	Electrical Conductance
Transparency[a]	Secchi Disk
Turbidity[a]	Nephelometric
Total Suspended Solids	Gravimetric
Dissolved Oxygen[a]	Probe[*]
Total Solids[b]	Gravimetric
Total Alkalinity	Potentiometric Titration
Calcium	AA/ICP[*]
Magnesium	AA/ICP
Potassium	AA/ICP
Sodium	AA/ICP
Chloride	Colorimetric
Fluoride	Colorimetric
Hardness ($CaCo_3$)	Equivalency Calculation
Silver	AA/ICP
Beryllium	AA/ICP
Antimony	AA/ICP
Zinc	Cold Vapor AA
Thallium	AA/ICP
Arsenic	AA/ICP
Selenium	Colorimetric
Cadmium	AA/ICP
Chromium	AA/ICP
Copper	AA/ICP
Nickel	AA/ICP
Lead	AA/ICP
Sulfate	Turbidimetric
Total Organic Carbon	TOC Analyzer
Nitrite & Nitrate Nitrogen	Colorimetric
Ammonia Nitrogen[a]	Colorimetric
Total Phosphorus[a]	Colorimetric

[a] Limited to surface water chemicals only.
[b] Limited to groundwater chemicals only.

[*] *Abbreviations:*
AA - Atomic Absorption Spectrophotometry
ICP - Inductively Coupled Plasma - Atomic Emission Spectroscopy
Probe - Specific Ion Probe

Table 5.4 Preoperational and Operational Storm Water Monitoring Program* (LES, 1994a)

Monitored Parameter	Monitoring Frequency		Sample Type
	Preoperational	Operational	
Oil and Grease	Annual	Quarterly	Grab
Total Suspended Solids	Annual	Quarterly	Grab
BOD	Annual	Quarterly	Grab
COD	Annual	Quarterly	Grab
Total Phosphorus	Annual	Quarterly	Grab
Total Kjeldahl Nitrogen	Annual	Quarterly	Grab
pH	Annual	Quarterly	Grab
Nitrate plus Nitrite Nitrogen	Annual	Quarterly	Grab
Uranium (gross alpha)	----	Quarterly	Grab

**Frequencies and parameters will be set by the discharge permits for nonradiological parameters.*

The air monitoring program contains meteorological and air quality monitoring components. Meteorological conditions at the facility location will be evaluated to characterize the LES site climatology and provide a basis for predicting the dispersion of gaseous effluents. Data used in the analysis will include wind, precipitation, and temperature. During the construction phase, CEC will initiate its meteorological monitoring program. LES has included a meteorological tower and instruments in its plans and intends to install meteorological instrumentation in accordance with NRC's Regulatory Guide 1.23. The tower will be located south of the plant. The distance from the tower to obstructions will be approximately 10 times the obstruction height in accordance with ANSI/ANS 2.5-1984.

The instruments will be located at a height of approximately 36.6 m (120 ft), which is the height of the top of the stack. The location complies with the guide, but the temperature and wind speed and direction will be slightly different than those collected using conventional weather station locations (temperature at 2 m elevation, wind speed at 10 m elevation). The net effect will be to indicate higher wind speeds with fewer changes in direction than at the normal elevation. Temperatures will fluctuate more rapidly at sundown/sunrise, and extremes will not be as large closer to ground level. Atmospheric dispersion models developed using weather service data may have increased error, but this should not be substantial due to the error inherent with most model estimates. The instruments intended for use are presented in Table 5.5.

The logged data will be processed on a computer for generation of joint frequency distributions of wind speed and wind direction as a function of atmospheric stability on an

Table 5.5 Meteorological Instruments (LES, 1994a)

Instrument	Range	Accuracy	Response
wind speed	0 - 100 mph	0.5 mph	
wind direction		1.5%	15°
temperature	-50 to 50°C	0.1°C	10 sec
data logger/translator			10 sec

annual and monthly basis. To ensure a 90-percent data recovery rate, instruments will be serviced as needed according to the manufacturer's recommendation.

Air quality data for existing levels of Clean Air Act (CAA) Criteria Pollutants will be presented and compared to the National Ambient Air Quality Standards (NAAQS). More detailed information on the proposed preoperational environmental monitoring programs is given in Section 6.1 of the LES ER (LES, 1994a).

5.2 Operational Effluent Monitoring Programs

Public exposure to uranium may occur as the result of small, controlled releases from the uranium enrichment process lines, during decontamination and maintenance of equipment, through releases of radioactive liquids to surface water, and transportation of UF_6 cylinders.

As the facility design is currently proposed, the major source of public exposure is expected to be from atmospheric releases. Such releases will be primarily controlled through the Separations Building ventilation system (LES, 1994a). All air to be released from contaminated areas of the facility will be filtered by prefilters and high-efficiency particulate air filters (HEPAs) to remove most airborne particulate radioactivity prior to discharge. The programs to measure such releases are discussed below.

5.2.1 Radiological Gaseous Effluent Monitoring Program

Minimum NRC requirements for monitoring radioactive effluents associated with normal operations were presented in the Advance Notice of Proposed Rulemaking (ANPR) for proposed 10 CFR Part 76 (NRC, 1988a). It was recommended that effluent releases during normal operations and the flow of the diluting medium (air) be measured, that the releases be as low as reasonably achievable (ALARA), and that concentrations of hazardous materials from effluents at or beyond the exclusion area boundary during normal or accident conditions not create any undue risk to the health and safety of the public (NRC, 1988a). This is reiterated in a draft NRC Regulatory Guide (NRC, 1992). The draft NRC Guide incorporates the elements of a Memorandum of Understanding (MOU) between EPA and

NRC regarding nonreactor facility effluent controls that would restrict offsite doses to an ALARA goal of 0.1 mSv (10 mrem) (TEDE) per year (57 FR 60778, 12/22/92). The LES effluent monitoring system will be capable of measuring the entire range of releases for normal operations and severe accidents. In addition, the proposed system can provide a measure of flowrate in the exhaust stack and the concentration of effluents being released. This will permit determination of the release rate from the stack (i.e., $pCi/m^3 \times m^3/sec$).

As discussed in Section 4.2, UF_6 hydrolyses in the presence of water vapor in air to form several byproducts, including hydrogen fluoride (HF). HF monitors are located in areas where there is a potential for UF_6 to be released to the atmosphere upstream of air filters in the ventilation system. The applicant estimates that these monitors will be capable of detecting 0.5 ppm of HF. Because air exhaust systems operate continuously during both normal operations and abnormal conditions (minor accidents), the monitors will provide continuous monitoring of any gaseous HF releases (accompanied by uranium as UO_2F_2) that might enter the ventilation exhaust ducts. Should the HF monitor alarm due to high HF concentrations in the GEVS, CEC will remove and analyze the isokinetic filter for gross alpha daily until the levels return to normal (LES, 1994c).

The gaseous effluent monitoring system will be a passive, continuous air sampler that will provide a weekly filter sample for analysis. The applicant has proposed as a license condition that the LLD for weekly gross alpha measurements be 3.7×10^{-11} Bq/ml (1×10^{-15} μCi/ml) (less than 2 percent of the Table 2 limit for any uranium isotope). These levels are above the normal background level of uranium in air, which is on the order of 7.4×10^{-13} Bq/ml (2×10^{-17} μCi/ml) (NCRP, 1987b). The LLD for uranium isotopic analyses done in response to running quarterly analyses (i.e., in excess of gross alpha action levels) shall not exceed 3.7×10^{-12} Bq/ml (1.0×10^{-16} μCi/ml) for each of the uranium isotopes, ^{234}U, ^{235}U, and ^{238}U (LES, 1994c).

Should the weekly gross analysis exceed the quarterly action levels of 4.4×10^{-9} Bq/ml (1.2×10^{-13} μCi/ml) for Unit 1, and 5.6×10^{-10} Bq/ml (1.5×10^{-14} μCi/ml) for Units 2 and 3, an investigation into the source of the elevated activity will be performed by CEC. If the action levels for gross alpha are exceeded by the quarterly average, isotopic analyses shall be performed. Further, isotopic analyses shall be performed on all semiannual composites of isokinetic samples, with an LLD not in excess of 3.7×10^{-13} Bq/ml (1.0×10^{-17} μCi/ml) for each of the uranium isotopes discussed above. The CEC Manager and Compliance Superintendent will be notified whenever action levels are exceeded, and the cause will be determined and corrected (LES, 1994c). The NRC staff finds that this combination of gross and isotopic LLD for weekly, quarterly, and semiannual samples will be adequate to provide early warnings of potential problems in the process confinement and treatment systems.

5.2.2 Radiological Liquid Effluent Monitoring Program

All potentially contaminated liquid effluents generated in the facility (primarily in the Separations Building) will be collected in one of several waste tanks prior to release to the

environment. More details are provided in the SAR, and the discussion here will be more general. A summary of the proposed liquid effluent system and flow paths were presented in Figure 2.12. All potentially contaminated liquid effluents are batch releases from storage tanks after the tank contents have been sampled and analyzed (prior to release to the Sewage Treatment System). This provides assurance that the concentrations at the point of release are far below the NRC 10 CFR Part 20 concentration limits in Appendix B, Table 2, and that the water quality meets the requirements of the Louisiana Administrative Code and U.S. EPA Water Quality Standards and Criteria.

Water from building roof drains, yard drains, and stormwater runoff will flow to the former Hold-Up Basin. Stormwater samples will be taken in accordance with the NPDES permit; these samples will also be analyzed for gross alpha. The proposed action level for gross alpha in stormwater is 7.5 Bq/ml (20 pCi/liter) above the background level (LES, 1994c). These liquids will be continuously discharged to Bluegill Pond, where the combined liquid flow will be sampled continuously for the composite monthly environmental monitoring analyses.

The ANPR guidance for sampling and measurement of radioactivity also applies generally to monitoring liquid effluents from the proposed facility (NRC, 1988a). Because essentially all of the radioactivity in liquid effluents will be removed and converted to solid waste prior to release, the concentrations of radioactivity in such effluents under normal operating conditions are expected to be very low.

CEC has proposed that all potentially contaminated liquids must be within 5 percent of the NRC Part 20 concentration limits (LES, 1994a) prior to release to the Sewage Treatment System and 0.5 percent following treatment and release to Bluegill Pond. If the 0.5 percent action level is reached, the CEC Manager and Compliance Superintendent would be notified; and the cause would be investigated, corrected, and documented. NRC finds those proposals acceptable. CEC has proposed a gross alpha LLD for the discharge sample from the Liquid Waste Disposal System of 5.6×10^{-6} Bq/ml (1.5×10^{-10} μCi/ml). The LLD for the Sewage Treatment System Discharge is 5.6×10^{-7} Bq/ml (1.5×10^{-11} μCi/ml). CEC will be able to measure background levels with this LLD. Therefore, the staff finds the LLD to be acceptable. Because ^{99}Tc is a long-lived contaminant found in some enriched uranium that may result in inadvertent contamination of UF_6 cylinders and CEC product, CEC will collect semiannual composite samples of the liquid effluent for ^{99}Tc analyses (LES, 1994c). The LLD will not exceed 1.1×10^{-2} Bq/ml (3.0×10^{-7} μCi/ml).

Additionally, LES has committed to sampling the sewage sludge for possible uranium accumulation on a semiannual basis. The LES action level will be 7.5×10^{-1} Bq/g (20 pCi/g). If the action level is exceeded, LES will investigate and take any necessary corrective action.

5.2.3 Radiological Effluent Monitoring Under Accident Conditions

The minimum NRC recommendations for monitoring radioactive effluents from a gaseous enrichment facility were presented in the ANPR for proposed 10 CFR Part 76 (NRC, 1988a). For accidental gaseous discharges, the ANPR required an appropriate means be provided to measure both the amount of radioactivity in gaseous effluents under accident conditions and the flow of the diluting medium (i.e., air). This guidance applies to CEC, and such measurements can be done by several independent systems.

For the serious accidents considered in Section 4 of this EIS, CEC intends to isolate the part of the Separations Building in which the accident occurs by turning off the ventilation system serving that room. Once ventilation flow stops, the only releases will result from small leakage pathways out of the room. Because each room has its own air mover, air flow up the stack will continue from the balance of the building, creating a small negative pressure in the ventilation system of the shutdown room. The small difference in atmospheric pressure between the shutdown room and the remainder of the operating ventilation system will in turn create a small flowpath from the room, through the ventilation ducts, and up the stack, unless a leak-tight damper can be closed to totally isolate the room.

While no effluent monitors in the shutdown section of the ventilation system would be able to provide a quantitative estimate of the release rate from the room (the flowrate would not be known), the slightly negative pressure in the shutdown ventline should help to ensure that airflow goes into the room containing the accident, through the ventilation system (where it is filtered), and up the stack where it can be measured. There will be at least one HF monitor in the ventilation system coming from the room where the accident occurred. Assuming this monitor survives the design basis accidents (DBAs), it can be used to provide live-time monitoring and alarm capability for UF_6 releases during post-accident recovery operations.

In the case of liquid effluents, all releases will be in batches sampled before release; and all liquids leaving the site will be added to the normal continuous flow of sewage treatment water that will be continuously sampled, composited, and analyzed quarterly. Due to the batch nature of potential radioactive releases to the sewage treatment water, an accidental release from failure of a single liquid waste line or tank is unlikely to reach the sewage effluents due to the series of holding tanks in the liquid effluent treatment system. For example, the facility will be designed so that if a line or tank fails or overflows, the contents will flow to a floor drain that will divert the flow to another holding tank. However, if an accident were to occur resulting in a serious liquid effluent release, additional samples could be taken as necessary for laboratory analysis of releases on a more frequent basis (e.g., daily or hourly) for gross alpha and beta radioactivity screening (high analytical sensitivity will not be required for such samples).

Liquid effluent sampling during accident conditions should be easy to implement. More frequent sampling and simple gross alpha/beta counting will detect concentrations ranging

from below NRC release limits up to concentrations far above the limits. While such requirements should be spelled out in emergency procedures, the technology should not represent a problem in implementation. Any accidental releases will be monitored and compared to preoperational data to help assess the extent of the release.

5.2.4 Nonradiological Effluent Monitoring Program

Specific information regarding the source and characteristics of all nonradiological plant wastes that will be collected and disposed of offsite, or discharged in various effluent streams is provided in the LES SAR (LES, 1993a). Chemical constituent quantities that will be discharged to the natural environment in facility effluents will be maintained below concentrations established by State and Federal regulatory agencies as protective of human health and the natural environment.

Prior to initiation of facility operation, and continuing on a quarterly basis thereafter throughout the life of the plant, additional ground and surface water samples will be collected, analyzed, and compared to the baseline data to monitor any impact the facility operations might have on water quality. Locations where water samples will be collected on a quarterly basis during facility operation are shown in Figure 5.2 and Figure 5.3. A list of the physiochemical parameters that will be analyzed for surface water and groundwater, along with the expected analytical methodologies for each, is presented in Table 5.3.

Stormwater monitoring will be conducted quarterly upon initiation of facility operation. Operational phase monitoring will be conducted upstream of the former Hold-Up Basin in order to demonstrate that runoff does not contain pollutants potentially resulting in the creation of contaminated sediments. A list of parameters to be monitored and monitoring frequencies are presented in Table 5.4. The proposed operational monitoring program is based upon the requirements contained in EPA's final rule for Drinking Water Standards, and NPDES Permit requirements.

The proposed monitoring and sampling program for chemicals in liquid effluents is described in the NPDES Application to the EPA and the permit application to the State of Louisiana (LES, 1992e). It is the NRC's position that nonradiological liquid effluents, while not within its regulatory purview, must meet the appropriate Federal and State standards. To demonstrate compliance with these standards, LES will be required to collect and analyze representative samples. LES must meet these standards in order to receive the necessary approvals for nonradiological discharges. As long as these standards are met, no significant impacts can reasonably be expected to occur (see Section 4.2.2.1). To ensure the receiving waters onsite and in offsite areas are not impacted by liquid effluents, LES will conduct an operational environmental monitoring program at the site, as well as at nearby locations (LES, 1994a and 1993a).

As already discussed, liquid wastes that may contain measurable concentrations of chemicals will be treated by evaporation and other means to remove chemicals and uranium, and the

remaining liquid wastes will be reduced to solids for traditional solid waste disposal. Those liquids that can be recovered and recycled (e.g., Fomblin Oil) will be reused to reduce waste production and costs. Non-aqueous liquid wastes such as lubrication oils and solvents will be disposed using approved methods.

As discussed earlier, the gaseous chemical effluent of major concern for the CEC facility is HF from the hydrolysis of UF_6 released into either the HVAC system or the gaseous effluent ventilation system (GEVS) for release out the stack. These releases are monitored in the ventilation system by the effluent monitors, as discussed in Section 5.2.1. The simultaneous loss of the total inventory of all other chemicals onsite was shown to have no significant offsite consequences.

To show compliance with the Clean Water Act (CWA), LES must provide evidence of continuing Section 401(a)(1) certification into the licensed period. Therefore, to ensure that the NRC is informed of any changes in the effectiveness of Section 401(a)(1) certification (once received), LES has agreed to inform the NRC within 30 days if the State-permitting agency revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued permit for the discharges of liquid effluents. LES has further agreed to inform the staff within 15 days of any violations of the State-issued discharge permit (LES 1994c).

5.3 Operational Environmental Monitoring Program

The operational environmental monitoring programs discussed in this section are generally a continuation of the preoperational programs already discussed. Therefore, excepting changes in frequency of certain sample collections and action levels, the technical requirements are so similar they need not be discussed again.

5.3.1 Radiological Environmental Monitoring Program

Direct radiation in offsite areas is expected to be undetectable because the low-energy x-rays associated with the uranium will be almost completely absorbed by the heavy process lines, equipment, and cylinders to be employed at CEC. Therefore, there are no requirements for offsite measurements of external radiation.

The Operational Radiological Environmental Monitoring Program is basically a continuation of the preoperational program, as summarized in Table 5.1. With the exception of monitoring for airborne particulates and surface water, the frequency of sampling of other media will decline from quarterly to semiannually. Airborne particulate sampling will continue to be collected weekly as during the preoperational program, while surface water sampling will be increased from quarterly grab samples to either continuous monthly composite samples (where practicable) or monthly grab samples. The LDEQ has indicated that the effluent discharge (Outfall 001) will be relocated to discharge below Bluegill Pond. Potential uranium accumulation in the sediments could occur in the streambed. Therefore,

the NRC staff recommends the streambed sediments be added to the monitoring program. The LLD, frequency, and action levels would be the same as for the remainder of the sediment sampling.

The LLD will remain the same as during the preoperational monitoring program. The proposed LLD are summarized in Table 5.2. The NRC finds that the sampling program and LLD for the operational program fully comply with NRC requirements and will be able to detect any signs of radioactive accumulation in the environment, and will therefore help to provide assurance in the future that operational doses to the public will be ALARA.

Table 5.6 Proposed Action Levels for Gross Alpha Environmental Analyses (LES, 1994a and 1994c)

Sample Type	Action Level
Water, Bq/ml (µCi/ml)	1.11×10^{-5} (3.0×10^{-10})
Air, Bq/ml (µCi/ml)	1.11×10^{-10} (3.0×10^{-15})
Soil/Sediment, Bq/g (µCi/g)	1.85×10^{-1} (5.0×10^{-6})
Vegetation, Bq/g (µCi/g)	3.7×10^{-4} (1.0×10^{-8})

Proposed action levels are given in Table 5.6. The action level (the level at which CEC will investigate causes of elevated releases, and initiate corrective action, if necessary) proposed for gross alpha (assumed to be uranium) in ambient air (1.1×10^{-10} Bq/ml or 3×10^{-15} µCi/ml), will be 3,000 times the LLD for uranium isotopes. This is about 150 times the typical background level of uranium (NCRP, 1987b), but only 0.1 percent of the 10 CFR Part 20 offsite concentration limit for uranium [i.e., corresponding to a CEDE of 0.0005 mSv (0.05 mrem)]. In the event any gross radioactivity measurement exceeds an action level, the sample will be subjected to prompt isotopic analysis. The level provides reasonable assurance that the detection capability will quickly identify any significant release problem and lead to prompt mitigation of the releases.

The proposed action level for gross alpha (assumed to be uranium) in surface or groundwater (3.0×10^{-10} µCi/ml or 1.11×10^{-5} Bq/ml) will be 300 times the LLD for uranium isotopes, about 3 or more times the average background level, but only 0.1 percent of the new NRC 10 CFR Part 20 concentration limit for uranium in water. A person drinking water at this concentration for a year would sustain a CEDE of 5×10^{-3} mSv (0.05 mrem) over the following 50-year period. NRC finds that the proposed action level for surface water or groundwater will provide reasonable assurance that CEC will maintain offsite concentrations well below the NRC limits. Also, as shown in Table 5.4, LES will sample stormwater for uranium with an action level of 20 pCi/l.

The proposed action level for gross alpha (assumed to be uranium) in soil or sediments [1.85×10^{-1} Bq/g (5.0×10^{-6} µCi/g or 5 pCi/g)] will be about 17 times the LLD and about

10 times the average background uranium concentration. While there are no regulatory limits for uranium in soil or sediments listed in the new NRC Part 20, the NRC Branch Technical Position (NRC, 1981a) will restrict uranium in soil remaining onsite following decommissioning of a facility (i.e., unrestricted use of the site) to 1.11 Bq/g (30 pCi/g, or 3.0×10^{-5} μCi/g). Therefore, the proposed action level will be about 20 percent of the level of the NRC Branch Technical Position, at the upper range of background uranium anticipated for the LES site. The NRC staff finds this proposed action level to be reasonable for protection of public health and safety.

The proposed action level for gross alpha (assumed to be uranium) in vegetation [3.7×10^{-4} Bq/g (1.0×10^{-8} μCi/g or 0.01 pCi/g)] is 100 times the LLD, and about 10 times the typical background level of uranium in vegetation (NCRP, 1987b). While no regulatory limits for uranium in vegetation are listed in the new NRC Part 20, consumption of 190 kg of vegetation (NRC Regulatory Guide 1.109 usage factor for adults) containing 2.6×10^{-4} Bq/g (0.007 pCi/g) of uranium results in an EPA "bone" dose of about 0.1 mSv (10 mrem). The proposed action level corresponds to a "bone" dose of about 0.14 mSv (14 mrem); somewhat high for a newly-licensed facility. Therefore, the staff recommends an action level of 1.85×10^{-4} Bq/g (0.005 pCi/g) to provide assurance that CEC will take prompt action to mitigate unacceptable releases from the facility.

Atmospheric releases will be the major source of public exposure, but will typically be diluted by factors around a million before reaching the nearest resident. Therefore, CEDEs to individuals in the offsite population will only be a small fraction of doses calculated for hypothetical exposures at the point of release during normal operations. Similarly, liquid releases, likely to be a secondary source of public exposure, will typically be diluted after release by orders of magnitude in surface waters or groundwater, resulting in much lower offsite doses. Based on these considerations and the fact that the LES facility will reflect the latest design and technology for gaseous centrifuge enrichment, the NRC staff finds that the proposed LES facility, coupled with an effective environmental monitoring program, will be able to limit all effluent releases and offsite concentrations to an ALARA level.

5.3.2 Nonradiological Environmental Monitoring Program

This section describes the operational surveillance monitoring program that will be employed by CEC to measure potential nonradiological chemical impacts upon the natural environment. CEC will continue the preoperational monitoring program at 10 sampling locations for surface water and 7 locations for groundwater (LES, 1994a). These numbers may be revised based on the EPA and State of Louisiana's future monitoring requirements.

The ability of both regulatory agencies and CEC operational personnel to detect and correct any potentially adverse chemical releases from the facility to the environment will rely on baseline chemistry data to be collected as part of the preoperational monitoring program. Data acquisition from these programs encompass both on- and offsite sample collection locations and chemical element/compound analyses commonly mandated by Federal and

State NPDES permit and the Louisiana Discharge Wastewater permit compliance and programs.

The range of chemical surveillance and analytical sensitivity incorporated into all the planned effluent monitoring programs for the facility should be sufficient to predict any relevant chemical interactions in the environment related to plant operations. In addition, to ensure that the facility's operation will have no substantial environmental impact, the CEC intends to limit chemicals in all facility effluents to levels below those prescribed by the State of Louisiana and EPA as being protective of human health and the natural environment.

The stormwater monitoring program also continues the preoperational monitoring program, but the sampling frequency is increased from annual to quarterly grab samples. The program is summarized in Table 5.4.

Meteorological monitoring during facility operations will consist of measurements of wind speed, wind direction, onsite temperature, and temperature difference (to estimate atmospheric stability). Data will be sampled once every 10 seconds. From these samples, hourly averages will be compiled and then used to produce joint frequency distributions of wind speed and direction as a function of atmospheric stability on a monthly basis. The monthly data will be used to construct an annual joint frequency distribution at the end of each calendar year.

6.0 FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

This chapter summarizes the major Federal and State of Louisiana environmental requirements applicable to the construction and operation of the Claiborne Enrichment Center (CEC).

Atomic Energy Act of 1954, as amended (42 U.S.C. § 2011 et seq.)

The Atomic Energy Act (AEA) of 1954, as amended, and the Energy Reorganization Act of 1974 provide NRC with licensing and regulatory authority for nuclear energy uses within the commercial sector.

U.S. Nuclear Regulatory Commission: Notice of Receipt of Application for License, Notice of Availability of Applicant's Environmental Report, Notice of Consideration of Issuance of License, and Notice of Hearing and Commission Order, Louisiana Energy Services, L.P., Claiborne Enrichment Center, Docket No. 70-3070, May 15, 1991.

The Commission Order established special standards and instructions, including those contained in the draft "General Design Criteria" contained in the Advance Notice of Proposed Rulemaking for 10 CFR Part 76, which apply with the same force as final NRC regulations. The Order specified that for the propose of siting and designing a facility against accidental atmospheric releases of UF_6, health and safety criteria contained in NUREG-1391 shall apply.

National Environmental Policy Act of 1970, as amended (42 U.S.C. § 4321 et seq.)

The National Environmental Policy Act (NEPA) establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment "to assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing environment." NEPA provides a process for implementing these goals within the Federal agencies. NEPA requires Federal Government agencies to prepare a detailed statement on the environmental effects of proposed Federal actions significantly affecting the quality of the human environment. NRC implements NEPA in 10 CFR Part 51 regulations.

Clean Air Act, as amended (42 U.S.C. § 7401)

The Clean Air Act (CAA) establishes the legal basis for promulgation of regulations for the preservation, protection, and enhancement of air quality. The CAA requires EPA to set standards for ambient air quality and hazardous air pollutants.

Clean Water Act, as amended (33 U.S.C. §1251 et seq.)

The Clean Water Act (CWA) requires EPA to set national effluent limitations and water quality standards, and establishes a regulatory program for enforcement. The State of Louisiana sets water quality standards for receiving bodies of water. These standards are applied through the National Pollutant Discharge Elimination System (NPDES) permits issued by EPA. According to Section 401 (a)(1) of the CWA, the State is required to certify that the permitted discharge will comply with all limitations necessary to meet established State water quality standards, treatment standards, or schedules of compliance. The NPDES permit program controls the discharge of pollutants into U.S. waters, and requires routine monitoring and reporting results.

Resource Conservation and Recovery Act (RCRA) (42 U.S.C. § 6901 et seq.)

The Resource Conservation and Recovery Act (RCRA), administered by EPA, provides "cradle-to-grave" control of hazardous waste. RCRA is designed to regulate hazardous waste by imposing management requirements on generators and transporters of hazardous waste and on owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (40 CFR 260-270). The State of Louisiana regulates hazardous waste and hazardous components of radioactive mixed waste. Radioactive component is regulated by NRC under the Atomic Energy Act of 1954. The regulatory authority is applied through RCRA operating permits for an interim status (RCRA Part A Permit) or permanent operation (RCRA Part B Permit). RCRA closure plans are required to identify procedures for removing hazardous waste management units from service and programs to prevent both short- and long-term threats to human health and the environment.

Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. § 9601 et seq.)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and its major amendment, the Superfund Amendment and Reauthorization Act (SARA), requires facilities to establish liability, investigate, and remediate the spills of hazardous substances that could endanger public health, welfare, or the environment. The Emergency Planning and Community Right-to-know Act (EPCRA) was enacted as a free-standing provision of the SARA in 1986. EPCRA (42 U.S.C. § 11001 *et seq.*), also known as SARA Title III, requires facilities to notify local and State emergency planning entities of the presence of potentially hazardous substances in their facilities and report the inventories and environmental releases of those substances.

Safe Drinking Water Act (42 U.S.C. § 300f et seq.)

The Safe Drinking Water Act (SDWA) provides for protection of public water supply systems and underground sources of drinking water. 40 CFR Part 141.2 defines public water supply systems as systems that provide water for human consumption to at least 25 people or at least 15 connections. Underground sources of drinking water are also protected from contaminated releases and spills by this Act.

Noise Control Act of 1972 (42 U.S.C. § 4901 et seq.)

The Noise Control Act transfers the responsibility of noise control to State and local governments. Commercial facilities are required to comply with Federal, State, interstate, and local requirements regarding noise control.

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

The National Historic Preservation Act (NHPA) was enacted to protect the nation's cultural resources. The NHPA is amended by the Archaeological and Historic Preservation Act (16 U.S.C. § 469a *et seq.*). This amendment directs Federal agencies in recovering and preserving historic and archaeological data that would be lost as the result of construction activities.

Hazardous Materials Transportation Act (49 U.S.C. § 1801 et seq.; Title 49 CFR Parts 106-179)

The Hazardous Materials Transportation Act (HMTA) regulates transportation of hazardous material (including radioactive material) in and between States. According to HMTA, States may regulate the transport of hazardous material as long as they are consistent with HMTA or the Department of Transportation (DOT) regulations that are posed in Title 49 CFR Parts 171-177. Other regulations regarding packaging for transportation of radionuclides are contained in Title 49 CFR Part 173, Subpart I.

Standards for Protection Against Radiation (Title 10 CFR Part 20)

These regulations establish standards for protection against radiation hazards arising out of activities under licenses issued by the Nuclear Regulatory Commission (NRC) and are issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. The regulations apply to all persons who receive, possess, use, or transfer licensed materials.

Environmental Standards for the Uranium Fuel Cycle (Title 40 CFR Part 190 Subpart B)

The provisions of this subpart establish the maximum radiation doses to the body or organs resulting from operational normal releases and received by members of the public.

Emission Standards for NRC Licensed Facilities (Title 40 CFR Part 61 Subpart I)

The provisions of this subpart establish limits on emission of radionuclides to air such that the public would not receive an effective dose equivalent exceeding 0.1 mSv/yr (10 mrem/yr).

Domestic Licensing of Source Material (Title 10 CFR Part 40)

The provisions of this regulation establish the procedures and criteria for the issuance of licenses to receive title to, receive, possess, use, transfer, or deliver source material.

Domestic Licensing of Special Nuclear Material (Title 10 CFR Part 70)

The regulations of this part establish procedures and criteria for the issuance of licenses to receive title to, own, acquire, deliver, receive, possess, and initially transfer special nuclear material; and establishes and provides for the terms and conditions upon which the Nuclear Regulatory Commission will issue such licenses.

Packaging and Transportation of Radioactive Materials (Title 10 CFR Part 71)

This regulates shipping containers and the safe packaging and transportation of radioactive materials under authority of the NRC and DOT.

Occupational Safety and Health Act of 1970 (29 CFR Parts 1900-1999)

The Occupational Safety and Health Act (OSHA) is designed to increase the safety of workers in the workplace. It provides that the Department of Labor is expected to recognize the dangers that may exist in workplaces and establish employee safety and health standards. The identification, classification, and regulations of potential occupational carcinogens are found at 29 CFR 1990.101, while the standards pertaining to hazardous materials are listed in 29 CFR 1910.120. OSHA regulates mitigation requirements and mandates proper training and equipment for workers.

Air Quality Regulations (Louisiana Administrative Code, Title 33, Environmental Quality Part XI)

These rules and regulations establish the permitting (Certificate of Approval) requirements for activities that would emit any air contaminants produced by a process other than natural.

Water Quality Regulations (Louisiana Administrative Code, Title 33, Environmental Quality, Part IX)

These regulations establish the Louisiana Water Discharge Permit System (LWDPS) requirements. The regulations specify effluent standards for facilities with sanitary discharges of less than 9,500 liters or 2,500 gallons per day (§709.B) and construction sites where the disturbed area is larger than 2 hectares or 5 acres (§709.H). The water quality regulations also institute the requirements for spill prevention and the surface water quality standards. Chapter 15 of these regulations establishes Water Quality Certification Procedures, which pertain to all facilities applying for Federal licenses.

Hazardous Waste (Louisiana Administrative Code, Title 33, Environmental Quality, Part V)

These regulations establish the permitting requirements for the generators of hazardous waste.

7.0 AGENCIES CONSULTED

During the preparation of this EIS, several local, State, and Federal agencies were consulted. These agencies are listed below.

Federal Agencies

U.S. EPA, Region VI
National Weather Service Station, Shreveport, LA

State Agencies

Department of Environmental Quality
- Office of Water Resources
- Office of Air Quality and Radiation Protection
- Water Pollution Control Division
- Water Quality Management Division

Department of Wildlife and Fisheries
Department of Transportation and Development
Department of Culture, Recreation, and Tourism
Department of Public Safety and Corrections

Local Agencies

El Dorado Airport, El Dorado, Arkansas
Claiborne Parish Health Department
Claiborne Parish School Board
Mayor, Haynesville, LA
Homer Memorial Hospital
Homer Police Department
Claiborne Parish Sheriff's Office
Homer Aviation Airport
Haynesville Police Department
Homer Chamber of Commerce

8.0 EIS PREPARERS

The organizations and individuals listed below are the principal contributors to the preparation of this Environmental Impact Statement (EIS). Table 8.1 summarizes the specific chapters to which each principal contributor provided input.

Contributor

U.S. Nuclear Regulatory Commission (NRC)

Merri Horn, M.S. Environmental Systems Engineering	NRC Project Manager (Environmental) Environmental Engineer
Yawar Faraz, B.S., CHP Nuclear Engineering	NRC Project Manager (Project) Health Physics
Lidia A. Roché, Ph.D. Physical Chemistry	Senior Physical Chemist
Edward Y. S. Shum, Ph.D. Nuclear Chemistry	Senior Environmental Engineer

Science Applications International Corporation (SAIC)

Ibrahim H. Zeitoun, Ph.D. Fisheries Sciences	SAIC Project Manager Senior Environmental Scientist
Joseph D. Price, Ph.D. Chemical Engineering	Senior Chemical Engineer
Reginald L. Gotchy, Ph.D., CHP Radiology and Radiation Biology	Senior Health Physicist
Brian D. Hillis, B.S. Chemical Engineering	Senior Air Quality Scientist
Samuel P. Figuli, M.S. Geology	Senior Hydrogeologist
Harry L. Chernoff, M.B.A. Information Management Systems	Senior Economist

Science Applications International Corporation (SAIC) (Cont'd)

Gabriel Sanchez, M.S.
International Business

Environmental Analyst

Gary M. DeMoss, M.E.A.
Engineering Administration

Senior Transportation Analyst

Table 8.1 Principal Contributors to the EIS

Principal Contributor	Summary and Conclusions	Chapters								Appendices	
		1	2	3	4	5	6	7	8	A	B
NRC											
Merri Horn, M.S.	X	X	X	X	X	X	X	X	X	X	X
Yawar Faraz, B.S., CHP	X	X	X		X					X	X
Lidia Roché, Ph.D.		X	X		X						
Edward Shum, Ph.D.		X	X	X	X	X	X				
SAIC											
Ibrahim H. Zeitoun, Ph.D. Fisheries Sciences	X	X	X	X	X	X	X	X	X	X	X
Joseph D. Price, Ph.D. Chemical Engineering	X	X	X		X					X	X
Reginald L. Gotchy, Ph.D., CHP Radiology and Radiation Biology			X	X	X	X					
Brian D. Hillis, B.S. Chemical Engineering				X	X						X
Samuel P. Figuli, M.S. Geology				X	X		X				X
Harry L. Chernoff, M.B.A. Information Management Systems	X	X		X	X						X
Gary M. DeMoss, M.E.A. Engineering Administration					X						
Gabriel Sanchez, M.S. International Business				X							X

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APPENDIX A

ASSESSMENT OF THE ENVIRONMENTAL IMPACTS OF DEPLETED UF_6 DISPOSITION

The depleted UF_6 (DUF_6) exiting the separation cascades will contain between 0.2 and 0.34 weight percent of ^{235}U and may be a potential resource. However, given the current large supply and limited market for this material, it is likely that the tails will ultimately require long-term disposal. The tails possession limit for the Claiborne Enrichment Center (CEC) will be 80,000 metric tons (88,200 tons) of DUF_6, or the amount produced after 15 years of production of DUF_6, whichever is less. Thus, no later than 15 years after commencement of CEC operations, the depleted tails will begin to be transported offsite. Due to the reactivity of DUF_6 with water, long-term disposal of DUF_6 will require conversion to a more chemically stable form. The following analysis provides a conservative assessment of the potential impacts of converting DUF_6 to triuranium octoxide (U_3O_8) and disposal of the U_3O_8.

A.1 Chemical Conversion of UF_6 to U_3O_8

A variety of uranium compounds, including uranium tetrafluoride (UF_4), uranium dioxide (UO_2), uranium trioxide (UO_3), and U_3O_8, are more stable in a geological environment than UF_6. The uranium fluorides, including UF_4, are less stable than the uranium oxides and produce hydrogen fluoride (HF) in reaction with water. Thus, the oxide forms are more favorable for long-term disposal. In the presence of oxygen (O_2), as is unavoidable in the conversion process, UO_2 and UO_3 are oxidized to U_3O_8 (Katz and Rabinowitch, 1951). U_3O_8 is readily produced from UF_6 and has potential long-term stability in a geological environment.

Three primary chemical processes are available for conversion of UF_6 to U_3O_8. In the first process, UF_6 is reduced to UF_4 through reaction with hydrogen. The UF_4 is subsequently reacted with water to produce U_3O_8. In the second process, UF_6 is reacted with water to produce uranyl fluoride (UO_2F_2), which is subsequently converted to ammonium diuranate [$(NH_4)_2U_2O_7$]. The $(NH_4)_2U_2O_7$ is then calcined to form U_3O_8. In the third process, UF_6 is reacted with steam in the gas phase to produce UO_2F_2, which is then reacted with hydrogen (H_2) and O_2 to produce U_3O_8. Each of these three processes will generate HF containing small amounts of uranium. The second process entails aqueous phase reactions, resulting in more complicated waste management. Both the first and third processes use gas phase reactions which produce byproduct streams which are more readily managed. The third process entails reaction steps used by commercial facilities in the U.S. and Europe. Based on these considerations, the thirli chemical process was selected as the basis for this analysis.

A.1.1 Generic Conversion Plant Site Description

The generic conversion plant site selected for evaluation covers an area of approximately 405 hectares (1,000 acres) and is located in the midwestern U.S. The site has a relatively mild continental climate with warm summers and mild winters. Total annual precipitation is approximately 104 cm (41 in), and winds are moderate with an annual average speed of 3.3 m/s (7.4 mph). Meteorological conditions are generally neutral, in Pasquill Classes C and D, 50 percent of the time. Stable meteorological conditions, Pasquill Class F, occur 12 percent of the time. The conversion plant is located adjacent to the banks of a major river which has an average flow of 45 m^3/s (1,590 ft^3/s). Population density in the vicinity of the plant is low, and the total population within an 80 km (50 mi) radius is approximately 400,000 people. The nearest resident is located near the plant boundary approximately 500 m (1,640 ft) from the plant's gaseous effluent release point.

A.1.2 Generic DUF_6 Conversion Process Description

The generic process for conversion of UF_6 to U_3O_8 utilizes a two-step reaction scheme supported by effluent controls for particulates released to the atmosphere and dissolved species released to surface water. The nominal capacity of the plant is 5,700 metric tons of UF_6 per year (6,270 tons/yr), allowing conversion of the expected inventory of CEC DUF_6 in approximately 20 years of operation. A process flow diagram of the conversion process is presented in Figure A.1 and the reaction stoichiometry is summarized in Table A.1

Table A.1 Reaction Stoichiometry for Conversion of DUF_6 to U_3O_8

Reaction 1 : Hydrolysis of UF_6

$$UF_6 + 2H_2O \rightarrow UO_2F_2 + 4HF$$

Reaction 2 : Conversion of UO_2F_2 to U_3O_8

$$3UO_2F_2 + 3H_2 + O_2 \rightarrow U_3O_8 + 6HF$$

Reaction 3 : Neutralization of HF

$$2HF + Ca(OH)_2 \rightarrow CaF_2 + 2H_2O$$

Feed DUF_6 is transported to the conversion plant site and stored on the site in Type 48G cylinders, each containing up to 12.7 metric tons (14 tons) of DUF_6. In the initial step of the process, DUF_6 is vaporized in an autoclave and fed to a hydrolysis reactor. The hydrolysis reactor operates at temperatures in excess of 300° C (570° F) (Chemical Abstracts, 1986), producing solid UO_2F_2 and gaseous HF. The solids and gases are separated in a series arrangement of porous metal filters. The particulate/gas separation efficiency of each filter is on the order of 99.9 percent (NRC, 1984). After the gases are cooled, they are routed to the HF scrubbers. The solid UO_2F_2 is fed to the second stage reactor, the conversion reactor. In the conversion reactor, the UO_2F_2 combines with H_2 and

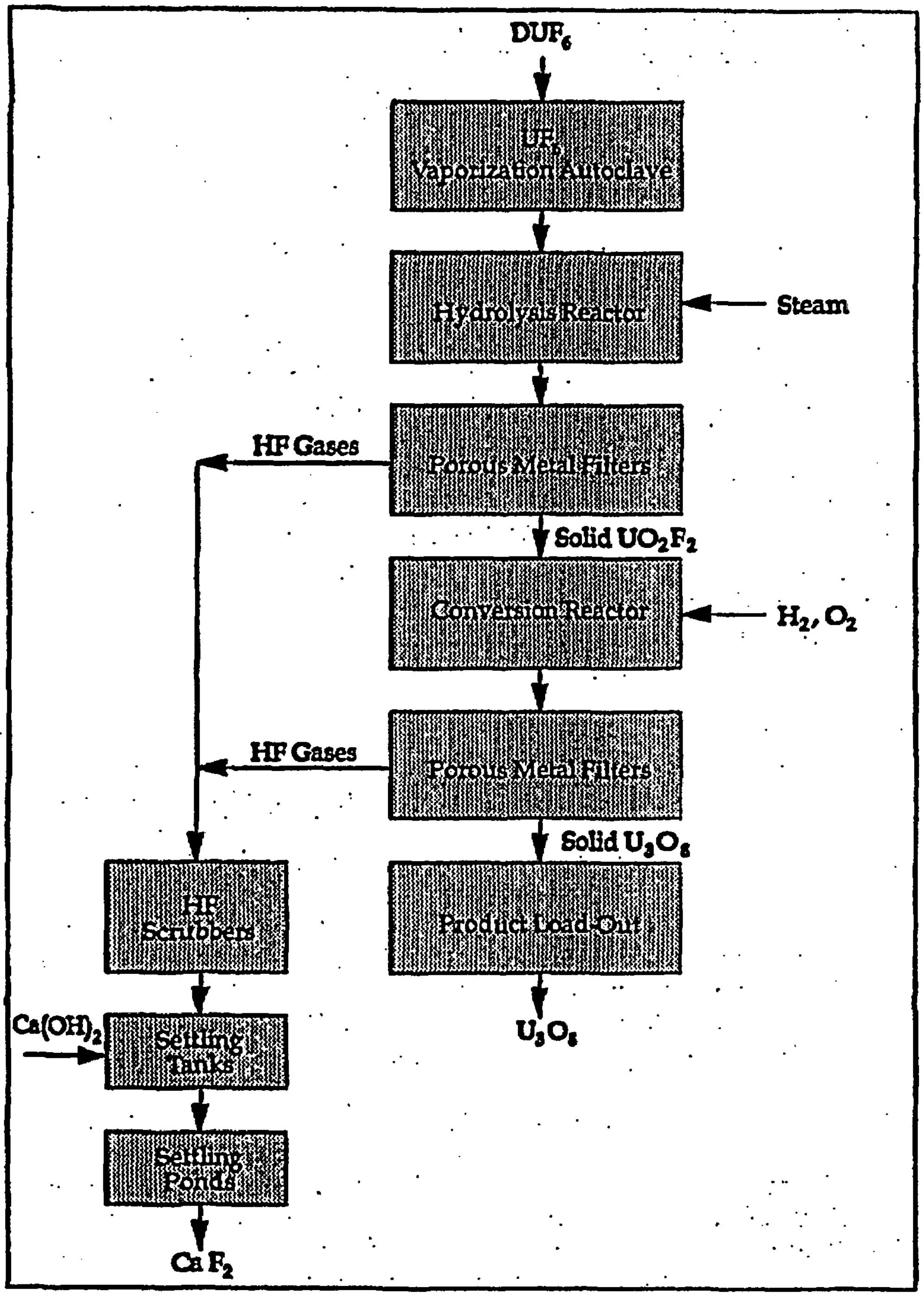

Figure A.1 Process Flow Diagram of the DUF_6 Conversion Process

O_2 at temperatures in excess of 750° C (1,380° F) (Harrington and Ruehle, 1959). Additional HF is generated in this reaction step. The H_2 used in the process is generated by catalytic dissociation of ammonia (NH_3) while the O_2 is introduced as air. Porous metal filters in series are again used to separate the U_3O_8 product from the reaction gases. The gas is combusted to consume residual H_2, cooled, and transferred to the scrubber system. Product U_3O_8 is transferred from the conversion reactor by a conveyor system and loaded into drums for storage and ultimate disposal. At the specified UF_6 feed rate, the plant would produce approximately 4,550 metric tons/yr (5000 tons/yr) of U_3O_8.

A.1.3 Generic DUF_6 Conversion Process Waste Management

The HF scrubber system uses a spray tower and packed tower operated in series to remove uranium particulates and HF from gases which are released to the atmosphere. The HF absorbed into the alkaline scrubber solution contains small amounts of uranium. As the scrubber solution is contacted with slaked lime [$Ca(OH)_2$] in a series of settling tanks, the HF is neutralized and converted to solid calcium fluoride (CaF_2). The reaction solution is transferred to lined settling ponds where the solids and water are separated. On a dry weight basis the maximum uranium content of the CaF_2 is estimated to be 0.05 Bq/g (1.4 pCi/g). Approximately $3.4x10^{+7}$ liters per year ($9.0x10^{+6}$ gal/yr) of water are estimated to be released to the environment from the scrubber system. In order to provide a conservative basis for impact analysis, all of the uranium entering the scrubber system is assumed to be released in the liquid effluent. Thus, the liquid release source term is approximately $1.92x10^{+8}$ Bq/yr (5,200 μCi/yr).

The primary sources of releases to the atmosphere are the HF scrubber off-gas and dust from the product load-out system. Particulate removal efficiencies are 80 percent and 99 percent for the spray tower and packed tower, respectively (Cheremisinoff and Young, 1976). Assuming approximately $1.92x10^{+8}$ Bq/yr (5,200 μCi/yr) enters the HF scrubbers, approximately $3.8x10^{+5}$ Bq/yr (10 μCi/yr) will be released in the scrubber off-gas. Product drum loading operations will be conducted in an area vented through fabric filters. Based upon experience with similar systems (NRC, 1984) and assuming a fabric filter efficiency greater than 95 percent (Perry and Chilton, 1973), approximately $3.0x10^{-5}$ weight percent of the U_3O_8 will be lost to the atmosphere. Based upon a U_3O_8 production rate of 4,550 metric tons (5,000 tons), approximately $2.89x10^{+7}$ Bq/yr (780 μCi/yr) of uranium will be released to the atmosphere from this source.

A.1.4 Dose Estimates for Generic DUF_6 Conversion Plant Operation

Radioactive material would be released to the atmosphere from the generic conversion plant at a height of 20 m (65 ft). The source term for the release is approximately $2.96x10^{+7}$ Bq/yr (800 μCi/yr) as described in Section A.1.3. Expected exposure pathways include inhalation of air, consumption of crops, direct exposure to the effluent plume and soil, and inadvertent ingestion of soil. Potential internal doses to the maximally exposed adult individual and the population surrounding the plant site for the atmospheric pathway

are presented in Table A.2. External dose to the whole body of an adult individual due to airborne and deposited uranium is estimated to be approximately 5.2×10^{-15} Sv/yr (5.2×10^{-10} mrem/yr). The critical individual for this pathway is an infant located at the residence nearest the plant. The estimated committed effective dose equivalent (CEDE) for the infant is 8.8×10^{-8} Sv/yr (8.8×10^{-3} mrem/yr), and the largest tissue dose is estimated to be 5.4×10^{-7} Sv/yr (5.4×10^{-2} mrem/yr) to the bone. For both the maximally exposed individual and the surrounding population, the exposures are only a small fraction of both background radiation and applicable limits, including the limits specified in 10 CFR Part 20, 40 CFR Part 61, and 40 CFR Part 190.

Table A.2 Potential Internal Doses to the Maximally Exposed Adult Individual and the Population Surrounding the Generic DUF_6 Conversion Plant

	Atmospheric Pathway		Liquid Pathway	
Affected Organ	Individual (Sv)	Population (Person-Sv)	Individual (Sv)	Population (Person-Sv)
Gonads	2.5×10^{-10}	1.2×10^{-6}	1.2×10^{-9}	3.8×10^{-5}
Breast	1.7×10^{-10}	7.6×10^{-7}	7.8×10^{-10}	2.4×10^{-5}
Red Bone Marrow	6.4×10^{-9}	2.9×10^{-5}	3.1×10^{-8}	9.3×10^{-4}
Lung	2.3×10^{-9}	1.3×10^{-5}	1.3×10^{-9}	4.1×10^{-5}
Thyroid	2.5×10^{-10}	1.2×10^{-6}	1.2×10^{-9}	3.8×10^{-5}
Bone Surface	9.8×10^{-8}	4.4×10^{-4}	4.9×10^{-7}	1.5×10^{-2}
Stomach	2.9×10^{-11}	1.3×10^{-7}	5.4×10^{-10}	1.6×10^{-5}
Small Intestine	3.9×10^{-11}	1.6×10^{-7}	1.2×10^{-9}	3.5×10^{-5}
Upper Large Intestine	1.3×10^{-10}	4.7×10^{-7}	7.4×10^{-9}	2.3×10^{-4}
Lower Large Intestine	4.2×10^{-10}	1.5×10^{-6}	2.3×10^{-8}	6.7×10^{-4}
Kidney	4.7×10^{-8}	1.8×10^{-4}	2.2×10^{-7}	6.6×10^{-3}
CEDE	7.0×10^{-9}	3.2×10^{-5}	3.4×10^{-8}	1.0×10^{-3}

Radioactive material would be released to surface water from the plant's waste management systems. The upper limit on these releases is estimated to be $1.92\times10^{+8}$ Bq/yr (5,200 µCi/yr) as discussed in Section A.1.3. Potential exposure pathways include ingestion of drinking water, crops and fish, and external exposure from boating and swimming. Potential internal doses for the maximally exposed adult individual and the surrounding population for the liquid pathway are presented in Table A.2. Liquid pathway external exposures are a small fraction of the internal exposures. The critical individual for the liquid pathway is an infant located at the residence nearest the plant. The estimated CEDE for the infant is 2.9×10^{-7} Sv/yr (2.9×10^{-2} mrem/yr), and the largest tissue dose is estimated

to be 1.8×10^{-6} Sv/yr (1.8×10^{-1} mrem/yr) to the bone. Individual and collective doses are both small fractions of background radiation and applicable limits, including those specified in 10 CFR Part 20 and 40 CFR Part 190.

The potential effect of depleted uranium storage at the conversion site is exposure of a receptor to gamma rays, bremsstrahlung, and x-rays due to direct and atmosphere-reflected (skyshine) transmission of radiation. For the purposes of this analysis, all cylinders of DUF_6 produced during 30 years of CEC operation are assumed to be stored in an unstacked rectangular array, on level ground, located at a distance of 1 km (0.6 mile) from the resident nearest the conversion site. The inter-cylinder spacings proposed for the CEC were adopted as a representative basis for this conversion plant analysis. In this storage configuration, the front row of cylinders would contribute almost all of the direct exposure, as radiation from cylinders in the interior of the array would be absorbed in surrounding cylinders. All cylinders would contribute to skyshine exposures.

Surface dose rates from a single cylinder containing DUF_6 are estimated to be less than 2×10^{-5} Sv/hr (2 mrem/hr) (Friend, 1991). Using this estimate of dose rate, the average annual dose to the nearest resident from direct radiation from all cylinders is estimated to be 1.8×10^{-7} Sv (1.8×10^{-2} mrem). Doses from skyshine were estimated using a computer code which applies the point kernel approach to calculate photon scattering dose. The annual dose (EDE) due to skyshine from all cylinders of DUF_6 is estimated to be 2.6×10^{-5} Sv (2.6 mrem) while the maximum annual tissue dose is estimated to be 2.9×10^{-5}Sv (2.9 mrem) to the thyroid. The combined direct and skyshine dose from all cylinders is a small fraction of background radiation and of applicable limits, including those specified in 10 CFR Part 20 and 40 CFR Part 190.

A.1.5 Cumulative Impacts of Generic DUF_6 Conversion Plant Operation

Nuclear Regulatory Commission (NRC) regulations (10 CFR 20.1301) require that the total effective dose equivalent (TEDE) for releases related to routine operations should not exceed 1 mSv/yr (100 mrem/yr). In addition, Environmental Protection Agency (EPA) regulations (40 CFR Part 190) require that for routine releases to the general environment, the annual dose equivalent should not exceed 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ. For releases to the atmosphere, EPA regulations (40 CFR Part 61) require that the annual effective dose equivalent should not exceed 0.1 mSv (10 mrem). For the critical individual, the cumulative annual CEDE (atmospheric and liquid pathways) is estimated to be 3.8×10^{-4} mSv (3.8×10^{-2} mrem) and the cumulative annual tissue dose is estimated to be 2.3×10^{-3} mSv (2.3×10^{-1} mrem) to the whole bone. The whole bone dose represents the effect on the entire bone tissue, including both the bone surface and the red bone marrow. The annual TEDE (atmospheric, liquid, and direct pathways) is estimated as 2.6×10^{-2} mSv (2.6 mrem) while the maximum annual tissue dose is estimated as 2.9×10^{-2} mSv (2.9 mrem) to the thyroid. Each of these doses is significantly lower than applicable limits and background radiation. Based on the analysis results presented above, it is concluded that

operation of the DUF_6 conversion plant is expected to have negligible radiological impacts on the environment.

A.2 Disposal of U_3O_8

U_3O_8 may be disposed by emplacement in near-surface or deep geological environments. Technologies applicable for near-surface disposal units include lined trenches, above- and below-grade vaults, and tumuli. This analysis assumes that the near-surface disposal unit is a tumulus with a 2-m thick compacted clay cover. Deep disposal facilities appropriate for disposal of uranium compounds include pre-existing mines and facilities engineered specifically for disposal. This analysis assumes that the disposal facility is pre-existing (that is, an abandoned mine or natural formation) with a minimum of engineered barriers. The objective of this analysis is to develop estimates of impacts for conditions which may be expected to occur at a carefully selected site. The analysis is not intended to assess generic impacts under all possible geological conditions.

The quantity of uranium assumed to be disposed is the 30-year CEC tails inventory (the amount adopted for analyzing the conversion of DUF_6 to U_3O_8), or approximately $9.1x10^7$ kg of U_3O_8. The crystal density of U_3O_8 is reported as 8.3 g/cm^3 (Katz and Rabinowitch, 1951), while bulk density can be as low as 3.0 to 4.0 g/cm^3 (Chemical Abstracts, 1986). In order to provide a conservative analysis, a bulk density of 3.0 g/cm^3 was used in this analysis. The U_3O_8 disposal volume is thus approximately $3.0x10^{+4}$ m^3. Initial activities of ^{238}U and ^{234}U are estimated to be approximately $9.6x10^{+14}$ and $2.7x10^{+14}$ Bq ($2.6x10^{+4}$ and $7.3x10^{+3}$ Ci), respectively. Consistent with the assumption of production in a fluidized bed process, the particles are assumed to have a small mean size with diameters on the order of 50 microns. For the near-surface case, the thickness of the disposed material is assumed to be 8 m, covering an area approximately 61 m long and 61 m wide. For deep disposal cases, the U_3O_8 is assumed to be emplaced at a thickness of 3 m, covering an area approximately 100 m long and 100 m wide.

The following sections present discussions of the approach used for the analysis, analysis methods and models, and the results of the analysis. The dose limits specified in 10 CFR Part 61 are adopted as a basis for comparative evaluation. Under this regulation, annual dose to any member of the public is limited to $2.5x10^{-4}$ Sv (25 mrem) to the whole body, $7.5x10^{-4}$ Sv (75 mrem) to the thyroid, and $2.5x10^{-4}$ Sv (25 mrem) to any other organ.

A.2.1 Disposal Analysis Methods

The tails disposal impact analysis approach includes selection of representative disposal sites, development of undisturbed performance, exposure scenarios, and selection of consequence estimation models. The characteristics of the sites selected for near-surface and deep disposal are described in the following paragraphs. Exposure scenarios selected for evaluation of near-surface disposal included drinking of well water and consumption of crops irrigated with water drawn from the well. Evaluation of the deep disposal case included undisturbed performance and well water exposure paths. In the undisturbed performance case, groundwater flows to a river which serves as a source of drinking water

and fish for an individual member of the public. For the well water exposure scenario, an individual drills into a deep aquifer down gradient from the disposal facility and uses the water for drinking and irrigation. Limits were not placed on the length of the evaluation period, and doses reported are the maximum that would be estimated for any time in the future.

The release rate of uranium and daughter radionuclides from the disposal facility is limited by their solubility in water or by the total inventory of radionuclide present at the time of release. In the case of a solubility limited release, the amount of radionuclide transported from the disposal facility is equal to the solubility multiplied by the flow rate of water through the facility. If the amount of a radionuclide present in the facility at a given time period is less than the amount of that radionuclide which could be removed during the time period by solubility limited release, the release could be considered inventory limited. For example, because an extremely small quantity of ^{226}Ra would be initially present in DUF_6, initial release of ^{226}Ra from the disposal facility would be inventory limited. As time passes, the facility inventory of ^{226}Ra would increase and a transition from inventory limited to a solubility limited release would occur. In order to provide a conservative assessment of potential impacts, inventory limited releases were not considered. In this analysis, solubilities are estimated using the PHREEQE computer code (Parkhurst et al., 1980) developed at the U.S. Geological Survey (USGS). Maximum concentrations of radionuclides present in the disposal unit are estimated using a computerized evaluation of the Bateman equation (Benedict et al., 1981). Concentrations of radionuclides in groundwater and corresponding doses were estimated using a code developed for this analysis. This code uses a combination of an analytic solution to the one-dimensional flow, three-dimensional dispersion equation developed by the USGS (Wexler, 1992), and unit soil contamination to dose factors developed with the RESRAD computer code (Gilbert et al., 1989). The code is capable of modeling retardation and decay during transport. The RESRAD factors incorporate the effects of direct exposure, inadvertent soil ingestion and ingestion of crops, meat, and milk. In the analytic solution code, drinking water doses are estimated as the product of predicted radionuclide water concentration, water intake rate (0.73 m^3/yr), and radionuclide ingestion dose conversion factor. Doses from fish ingestion are estimated as the product of water concentration, bioaccumulation factor, consumption rate, and ingestion dose conversion factor. Bioaccumulation factors are the same as those used in NRC analysis of decommissioning scenarios (Kennedy and Strenge, 1992). The dose conversion factors are consistent with present Federal regulatory guidance (Eckerman et al., 1988). The estimations were corroborated using the PRESTO-EPA (Fields et al., 1987) computer code to recalculate near-surface disposal scenario impacts. PRESTO is a pathway analysis code developed for analysis of impacts of disposal of radioactive waste.

For deep disposal, intrusion into the emplacement horizon is not an expected event. However, direct, inadvertent drilling into the U_3O_8 as a result of resource exploration was considered. The EPA has proposed occurrence frequencies for intrusion events due to exploratory drilling for resources into a deep disposal unit (EPA, 1994). The recommended occurrence frequencies are $3x10^{-3}$ boreholes/km^2/yr for sedimentary formations and

$3x10^{-4}$ boreholes/km^2/yr for other geological formations. Due to the relatively small area of the disposal facility, the estimated frequency of occurrence of this event is small, on the order of $3x10^{-6}$/yr. Also, groundwater flow rates through the facility would be low and the water extracted as a result of exploratory drilling would not likely be used for potable or irrigation purposes. Thus, the radiological consequences of groundwater brought to the surface through direct intrusion into the U_3O_8 would be insignificant. The consequences of drilling into the U_3O_8 could include transport of approximately 0.2 m^3 (7.7 ft^3) of U_3O_8 to the surface with the drilling mud and cuttings. The material would most likely be deposited in the drilling mud pond. The potential impacts, including exposure of workers to resuspended, contaminated dust would be small and transient. For these reasons, the impacts of drilling into the U_3O_8 were not evaluated in detail.

In the well scenario, the horizontal and vertical locations of the well and its take-off point, respectively, are intrinsically uncertain elements of the scenario. A water well is more likely to be screened in the upper rather than the lower portion of a deep, homogeneous, hard-rock aquifer. In this analysis, the well take-off point is assumed to be at the center elevation of the aquifer. One horizontal location of the well is as likely as the site of a well as any other. In order to provide a conservative analysis, the well was located at the distance of maximum dose for the center elevation of the aquifer.

A.2.2 Near-Surface Disposal of U_3O_8

The estimates developed in this analysis focus on the impacts of disposal of U_3O_8. Prior analysis (Kozak et al., 1992) considered potential impacts of disposal of UF_6, UF_4, and U_3O_8 in near-surface disposal facilities. The characteristics of the disposal site were those of the humid southeastern U.S. This prior analysis noted that reaction of UF_6 and UF_4 with water would produce quantities of HF which could compromise the integrity of the disposal facility and significantly disturb the environment. Consequently, drinking water, intruder construction, and intruder agricultural scenario doses were unacceptably high for the fluorinated waste forms. The Kozak analysis also included consideration of potential impacts of near-surface disposal of U_3O_8. Release of uranium was modeled as being controlled by its solubility, which in the oxygenated near-surface environment was estimated as less than $2.4x10^{-3}$ g/L. The Kozak analysis concluded that doses would exceed the $2.5x10^{-4}$ Sv/yr (25 mrem/yr) limit specified in 10 CFR Part 61. Using infiltration rate and aquifer flow rate for the humid southeastern site, the doses presented in Table A.3 were estimated using the methods of this Environmental Impact Statement (EIS) for release from a near-surface U_3O_8 disposal facility. It should be noted that the estimated doses are significantly above the limits specified in 10 CFR Part 61, even though the reported results do not include the potential effects of ingrowth of uranium daughters or of intruder construction scenarios. The analytic model and PRESTO results are consistent, indicating similarity of the pathway models. Because for near-surface disposal of U_3O_8, projected doses exceed 10 CFR Part 61 limits, a deep disposal site is most likely to be selected for ultimate disposition of depleted uranium.

Table A.3 Drinking Water and Agricultural Scenario Doses for Near-Surface Disposal of U_3O_8, (Sv/yr)

	Analytic Flow/ RESRAD Model	PRESTO
Drinking Water Dose	5.7×10^{-3}	5.8×10^{-3}
Agricultural Dose	3.1×10^{-4}	3.7×10^{-4}

A.2.3 Deep Disposal of U_3O_8

At the present time, candidate sites for the deep disposal of U_3O_8 have not been identified. In order to compensate for lack of detailed knowledge of a specific site, two sites, whose geological structures have previously been characterized, have been assumed and analyzed. The characteristics of these sites are representative of natural variability and expected conditions for deep disposal. For each of the sites, release of radionuclides would be controlled by solubility limited dissolution in water flowing through the disposal facility. The effects of potential engineered barriers and retardation during vertical transport are neglected.

Generic Deep Disposal Site Descriptions

The characteristics of the two sites used for evaluation have been developed in prior studies of radioactive waste disposal. The sites are assumed to be located in the U.S. and have the geological structures depicted in Figure A.2. Site 1 (Rechard, 1993) is located in a granite formation overlain by a thin layer of glacial till. The disposal horizon is located at a depth of 290 m (0.18 mi) below ground surface. It is intersected by vertical fractures, allowing transmission of water upward through the U_3O_8 matrix to a horizontal fracture zone (deep aquifer), which in turn carries water toward a river. Site 2 (Stottlemyre et al., 1979) is located in a sequence of interbedded sandstone and basalt layers. The U_3O_8 is emplaced in a sandstone layer 635 m (0.39 mi) below the ground surface. Local upward flow carries water through the U_3O_8 matrix to a cemented sand and gravel strata (deep aquifer) which intersects with the river. The fracture sizes, densities, hydraulic conductivities, and permeabilities used in this evaluation are the same as those reported in the original studies (i.e., Rechard, 1993 and Stottlemyre et al., 1979). A list of the groundwater flow path parameters and the values used for analyzing the transport paths is presented in Table A.4.

Solubility Estimates

The solubility of a radionuclide in groundwater depends on the concentrations of naturally occurring ions in the groundwater and on the physical/chemical characteristics, for example, pH, eH, and temperature of the water. Thus, in order to predict representative concentrations of a dissolved specie, the characteristics of the groundwater must be established. The chemical analysis for an actual near-surface groundwater (WVNS, 1993),

a) Site 1: Granite Formation

Thickness* (m)	Lithology	
6	Glacial till	290 m
125	Pink granite	
75	Upper fracture zone	
175	Gray granite (emplacement horizon)	
10	Lower fracture zone	

b) Site 2: Sandstone/Basalt Layers

Thickness* (m)	Lithology	
125	Sand and gravel	635 m
200	Cemented sand and gravel	
300	Basalt	
25	Sedimentary interbed (emplacement horizon)	
200	Basalt	

**Not to scale*

Figure A.2 Geologic Structure of Generic Deep Disposal Sites

Table A.4 Flow Path Parameters for Generic Deep Disposal Sites

	Hydraulic Conductivity (m/yr)	Flow Area (m^2)	Gradient (m/m)
Site 1 (Granite)			
Vertical Path	8.03	4.0	0.02
Horizontal Path	30.9	7.5×10^3	0.005
Site 2 (Sandstone/Basalt)			
Vertical Path	0.04	1.0×10^4	0.05
Horizontal Path	308.7	2.0×10^4	0.005

which has the characteristics similar to deep groundwater, was selected for this assessment. The most significant characteristics of the groundwater selected for this analysis are presented in Table A.5. Also included in the table, for comparison purposes, are ranges of characteristics of deep groundwater and of uranium mine water reported in a study of radioactive waste disposal (KBS, 1978). The literature values indicate that the selected groundwater analysis is representative of conditions expected for deep disposal locations. Solubilities for individual radionuclides based upon that groundwater were calculated using the PHREEQE (Parkhurst et al., 1988) computer code and thermodynamic data from the CODATA data set maintained by the International Atomic Energy Agency (Muller, 1985). The calculation procedure involves identifying dominant solid phases, and the sum of the concentrations of all aqueous forms of an element is reported as the solubility of that element. The results of the calculations are presented in Table A.6.

Table A.5 Characteristics of Ground Water Used for Deep Disposal

Constituent	Selected Ground Water	Deep Ground Water Ranges	Uranium Mine Water Ranges
Cl^- (mg/L)	4.4	5-50	5 - 16
HCO_3^- (mg/L)	205.7	60-400	183 - 441
SO_4^{-2} (mg/L)	178.2	1-15	15 - 863
pH	7.8	7.2-8.5	6.5 - 7.8
eH (mv)*	-100	-	60 - -89

* *Redox Potential*

Table A.6 Calculated Solubilities of Elements in Selected Deep Ground Water[a]

Nuclide	Solubility (mg/L)	Dominant Solid Phase	Dominant Aqueous Phase
Uranium	$1x10^{-4}$	UO_2	$U(OH)_4$
Thorium	$5x10^{-13}$	ThO_2	$Th(OH)_3^+$
Radium	$1x10^{-2}$	$RaSO_4$	Ra^{+2}

[a]Deep groundwater has the characteristics given in Table A.5.

Radionuclide Transport

Groundwater seeping vertically through the disposal facility is assumed to carry dissolved radionuclides upward to a more permeable unit (aquifer). After entering the aquifer, the radionuclides are dispersed upward and transported horizontally through the aquifer by the predominantly horizontal flow. The effects of mixing in the horizontal flow are represented by inclusion in the model equations of a term for hydrodynamic dispersion. The magnitude of the mixing is quantified by longitudinal and transverse dispersion coefficients whose values for fractured granite and for sandstone formations are estimated based on review of field experiments (Waldrop, 1985). Values of longitudinal dispersion coefficients of 30.9 and 61.7 m^2/yr were selected for the granite and sandstone/basalt sites, respectively. Values adopted for transverse dispersion coefficient are one-tenth the magnitude of the longitudinal coefficients based on data review (Waldrop, 1985) and theoretical considerations (Bear, 1972). Radionuclides dissolved in groundwater are adsorbed and exchanged through contact with the surrounding solid phase and thus travel at a lower velocity than the groundwater. Experimental observation of uranium, thorium, and radium in fractures at a mine site (Dearlove et al., 1989) and at hard rock sites in general (KBS, 1978 and National Research Council, 1983) indicate that the ratio of water to radionuclide velocity for these radionuclides ranges from several thousands to tens of thousands in these environments. The recommendation (KBS, 1978) of retardation coefficients greater than 1,200 for uranium, thorium, and radium was adopted for this assessment.

Impacts of Deep Disposal of U_3O_8

Potential radiological exposure pathways related to emplacing U_3O_8 in deep geological environments include consumption of drinking water, irrigated crops, and fish. Under expected conditions the groundwater would discharge to a river prior to intake. In this analysis, the river is assumed to be located 5 kilometers from the disposal facility. Under conditions which are not expected to occur, an individual would obtain water by drilling a deep well downgradient from the disposal facility. The analysis established that maximum dose for the mid-aquifer elevation well take-off point would occur at a distance of 200 meters at both the granite and sandstone/basalt sites.

The analysis considers radionuclides present in the emplaced U_3O_8 and radionuclides which may be produced by decay of parent radionuclides during transport. Because of low solubility and short half-lives, decay daughters of radium originating at the disposal facility would not make a significant contribution to dose at the 200 m well and river locations. Due to the relatively high solubility of radium and the relatively low solubility of uranium and thorium, radium originating at the disposal facility and its shorter half-life daughters growing in during transport would dominate dose at the 200 m well location. At the 5 kilometer river location, radium originating at the disposal facility would have decayed to comparably insignificant levels and radionuclide concentration levels would be controlled by the uranium isotopes. The assumptions of secular equilibrium of the daughters of radium with radium at the 200-meter well and other daughters of uranium with uranium at the 5 kilometer river locations are applied to assess the contribution of daughter ingrowth during transport.

Estimates of doses for the well scenario for the granite and sandstone/basalt sites are presented in Table A.7. Dose estimates for the river scenario for both sites are presented in Table A.8. At the 200-meter well, the parent radionuclide which dominates the estimated dose is ^{226}Ra, while at the river, ^{238}U is the dominant radionuclide. Each of these estimates is the maximum annual dose that would be predicted for any time in the future.

For all of the results presented, estimated impacts are less than the 0.25 mSv/yr (25 mrem/yr) level adopted from 10 CFR Part 61 as a basis for comparison. The assumptions applied in this analysis, including neglect of engineered barriers, inventory limitations, mass transfer limitations in release, and decay and retardation during vertical transport contribute to a conservative analysis.

Table A.7 Estimated Peak Doses for Well Scenario (Sv/yr)

	Granite Site		Sandstone/Basalt Site	
Nuclide	Drinking Water Dose	Agricultural Dose	Drinking Water Dose	Agricultural Dose
^{238}U	$5.0x10^{-14}$	$2.3x10^{-15}$	$2.3x10^{-20}$	$1.0x10^{-21}$
^{234}U	$5.3x10^{-14}$	$1.6x10^{-15}$	$2.5x10^{-20}$	$7.5x10^{-22}$
^{230}Th	$3.1x10^{-17}$	$1.8x10^{-16}$	$1.6x10^{-23}$	$9.0x10^{-23}$
^{226}Ra	$4.9x10^{-8}$	$1.3x10^{-6}$	$4.0x10^{-11}$	$1.0x10^{-9}$
^{226}Ra Daughters	$1.1x10^{-7}$	$1.0x10^{-6}$	$8.8x10^{-11}$	$8.0x10^{-10}$

Table A.8 Estimated Peak Doses for River Scenario (Sv/yr)

	Granite Site		Sandstone/Basalt Site	
Nuclide	Drinking Water Dose	Fish Ingestion Dose	Drinking Water Dose	Fish Ingestion Dose
^{238}U	$2.6x10^{-17}$	$3.7x10^{-17}$	$7.9x10^{-16}$	$1.1x10^{-15}$
^{234}U	$2.9x10^{-17}$	$4.1x10^{-17}$	$8.8x10^{-16}$	$1.2x10^{-15}$
^{230}Th	$5.6x10^{-17}$	$1.6x10^{-16}$	$1.7x10^{-15}$	$4.7x10^{-15}$
^{226}Ra	$1.3x10^{-16}$	$2.6x10^{-16}$	$4.0x10^{-15}$	$7.8x10^{-15}$
^{226}Ra Daughters	$2.9x10^{-16}$	$5.1x10^{-16}$	$8.8x10^{-15}$	$1.5x10^{-14}$

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11. ABSTRACT (200 words or less)

This Final Environmental Impact Statement (FEIS) was prepared by the Nuclear Regulatory Commission in accordance with NRC regulation 10 CFR Part 51, which implements the National Environmental Policy Act (NEPA), to assess the potential environmental impacts of the construction and operation of a proposed gaseous centrifuge enrichment facility to be built in Claiborne Parish, LA. The proposed facility will have a production capacity of about 866 tonnes annually of up to 5 percent enriched UF_6, using a proven centrifuge technology. Included in the assessment are construction, both normal operations and potential accidents (internal and external events), and the eventual decontamination and decommissioning of the site. In order to help assure that releases from the operation of the facility and potential impacts on the public are as low as reasonably achievable, an environmental monitoring program was developed to detect significant changes in the background levels of uranium around the site. Other issues addressed include the purpose and need for the facility, the alternatives to the proposed action, the site selection process, environmental justice, and tails disposition. The NRC concludes that the facility can be constructed and operated with small and acceptable impacts on the public and the environment. The FEIS supports licensing.

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